

**BOULDER RESERVOIR
2013 BIOLOGICAL SURVEY
AND RECREATION IMPACT ASSESSMENT**

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Prepared for:
City of Boulder Parks and Recreation Department



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EXECUTIVE SUMMARY

As recreational pressures increase at the Boulder Reservoir, there is a critical need to develop a Site Management Plan that strikes a balance between natural resources and recreation management. The purpose of this biological assessment report is to provide information that will support the development of the Site Management Plan. The project scope included baseline inventories of vegetation and wildlife resources; establishment of ecological management zones and priority conservation targets; analysis of recreational activities and potential impacts to resources; development of protection strategies and recommendations, and description of adaptive management and monitoring approaches.

Landscape setting and physical resource information were used to refine the Management Zones from the Boulder Reservoir Master Plan and create Ecological Management Zones based on areas with similar characteristics. The Ecological Management Zones include: Dry Creek, Little Dry Creek, Coot Lake and Wetlands, North Shore, North Dam, South Dam, South Shore, and Western Uplands.

Plant Communities. Four native plant communities – Mixed Grass Prairie Mosaic, Riparian, Woody Wetland, and Herbaceous Wetland – total about 234 acres at Boulder Reservoir and are located primarily in the Dry Creek, Little Dry Creek, and Coot Lake Management Zones. The most ecologically significant vegetation communities of the Boulder Reservoir are the large areas of native herbaceous wetland, the remnant areas of mixed grass native prairie, and the uncommon salt flat areas. These areas are important due to their extent, high proportion of native species, and lower intensity and frequency of disturbance relative to the highest-use areas of the Reservoir. The rare plant area identified on the northwest side of the Reservoir in the Boulder County Comprehensive Plan is another area of important ecological significance.

The encroachment of non-native species into areas of native vegetation is a major concern. Most of the plant communities would benefit from restoration to increase native plant diversity, improve wildlife habitat, and increase their overall adaptability to future pressures including climate change. Non-native uplands and Non-native riparian communities would benefit from restoration activities targeting the removal of invasive species and reestablishing robust native species populations. Connectivity of vegetation communities including habitat connections to adjacent properties, is another issue of concern for the Parks Department to manage and monitor. In general, wildlife connectivity is greater among native plant communities than between a native and a non-native community.

Wildlife. The 2013 wildlife surveys identified the presence of many of the general mammals, amphibian, reptile and bird species that were expected to be present based on the habitat type, including two of the expected four species of turtle and three of the eight expected species of snake. Mammal species that were detected in grid surveys or at camera scent stations included: Black-Tailed Prairie Dogs, Mink, Muskrat, Coyote, Raccoon, Eastern Cottontail Rabbit, and Ermine (Short-Tailed Weasel). The small mammal trap surveys found species richness and diversity were unexpectedly low in 2013. Contributing factors could include lingering effects of the 2012 drought, recreational impacts from humans and dogs, normal population fluctuations, low cover height of vegetation, and/or disease..

The 2013 bird survey identified the presence of 114 bird species, 82 of which were potential breeders. Fifteen of the birds observed in 2013 are Boulder County or Colorado Natural Heritage Program species of concern, nine of which are potential breeding species: these include four American Bittern nesting territories in the Dry Creek and Coot Lake wetlands. The wetlands on the west side of Boulder Reservoir are the only place in Boulder County where Northern Harriers (Boulder County rare and declining; imperiled) have nested successfully during the past nine years. No evidence of Northern Harrier nesting was observed during 2012 or 2013; although, the recent observations from 2014 found Northern Harriers were nesting in the Little Dry Creek drainage. Protection, conservation, and enhancement of these important nesting areas are vital. Burrowing Owls (Boulder County isolated and restricted; imperiled) have nested sporadically in prairie dog colonies surrounding the Reservoir; however, none were observed

in 2012 or 2013. In 2013, American Bitterns failed to nest in the Little Dry Creek drainage for the first time since 2004; however, 2014 monitoring observed two active nesting territories—one on either side of 51st Street.

Based on the results of the biological surveys, the primary conservation targets or priorities (in no particular order) include:

- Mixed Prairie Mosaic
- Wetlands – Herbaceous and Woody
- Riparian Areas
- Native Wildlife – including Small Mammals, Amphibians & Reptiles
- Black-tailed Prairie Dog and Associates (Burrowing Owl)
- Bird Species of Concern

Recreation Impacts and Protection Strategies. The long-term viability of the conservation targets varies across the property, depending on the intensity of stress on the system. At the Reservoir, examples of sources of stress include:

- Visitor and vehicular disturbance due to proximity and noise particularly near nesting and forage areas,
- Domestic dog disturbance particularly off-leash and swimming near nesting and forage areas,
- Vegetation trampling from social trails and trail widening,
- Habitat fragmentation and loss from roads, trails, developed facilities,
- Water quality and pollution from direct discharge or offsite development and land use,
- Immigration of invasive species from direct transport, waterways, or dispersal from nearby properties,
- Monocultures in part from fire suppression, grazing pattern changes, and lack of active management
- Increased competition & predation by non-natives such as bullfrogs (and natives such as coyote).

Priority Goals. Four priority goals are proposed for the biological resources of the Reservoir:

- Goal 1:** Maintain or expand the size of existing native wetland, riparian, mixed grass prairie plant communities.
- Goal 2:** Maintain or improve the condition of native wetlands, riparian and mixed grass prairie grassland communities in best opportunity areas.
- Goal 3:** Restore degraded, non-native grassland and riparian habitats to eliminate non-native elements, establish buffers, and improve connectivity in best opportunity areas.
- Goal 4:** Protect wildlife habitat to support species of concern and a diversity of native birds, amphibians, reptiles, and small mammals.

To achieve these goals, protection levels and suitable recreational uses are recommended for Best Opportunity Areas, or areas at the Reservoir with the greatest potential for improvement with respect to restoration and/or protection. Dry Creek, Little Dry Creek and Western Uplands, and Coot Lake wetlands are identified as maximum protection areas; Coot Lake (east side), North Shore, North Dam and South Dam are moderate protection areas; and the South Shore is a minimum protection area. Recommended approaches for various management strategies are identified in this report to lay the framework for the Site Management Plan. Recommended improvements to vegetation and habitat management include signage, education, guided tours, gates and fencing, enforcement, restoration, and monitoring.

The important types and number of native plants, birds, and wildlife found at the Reservoir merit a renewed commitment by the city to long-term stewardship. The challenges presented in balancing biological resources with users' recreational demand are certainly daunting, yet are not expected to diminish. Successful protection and management will depend on adequate funding and staffing to implement the Site Management Plan and ensure the Reservoir's valuable ecological resources survive and thrive for future generations.

1. INTRODUCTION

1.1. Project Background

Freshwater lakes surrounded by large areas of diverse habitat types, such as found at Boulder Reservoir, are relatively rare in semi-arid Colorado. For example, of all the water bodies mapped in northeastern Colorado, fewer than one percent are larger than Boulder Reservoir (i.e., only 32 out of 28,500 lakes in the South Platte Division 1). The location of the Reservoir near the edge of the foothills and surrounded by rural and protected open space adds to its unique significance. As a result, the Reservoir offers highly valuable habitat for wildlife, and it is also a favorite recreation area for both local and regional visitors due to its proximity to the Denver metropolitan area and other Rocky Mountain attractions.

The importance of the environmental resources around the Reservoir was highlighted in the 2013 update of the Boulder County Comprehensive Plan (Boulder County, 2013). At the landscape scale, the county designates Environmental Conservation Areas (ECAs) that “*possess a relatively low amount of fragmentation, contain high quality natural resources or habitats, are designated at a sufficient size to provide ecological benefit, and/ or have significant potential for restoration.*” The lands adjacent to the Reservoir and Coot Lake to the west and north are included within the Boulder Valley Ranch/Beech Open Space ECA. The 2013 Update also designates these areas of the Reservoir as:

- Critical Wildlife Habitat: *An area of unique habitat which has a crucial role in sustaining populations of native wildlife and in perpetuating and encouraging a diversity of native species in the county. The area may be significantly productive habitat or particularly vital to the life requirements of species that are critically imperiled or vulnerable to extirpation;*
- Wetlands and Riparian Areas (includes areas to the east and south of the Reservoir); and a
- Rare Plant Area: *“known to have or have a high likelihood of having occurrences of Plant Species of Special Concern.”*

In 2012, the city completed its Boulder Reservoir Master Plan which establishes a framework for future decision making including an Implementation Plan. The goals and objectives in the Master Plan include preparation of a detailed Site Management Plan and collection of additional information, including this biological species inventory.

1.2. Purpose & Scope

The purpose of the current biological inventory and analysis is to provide a basis for ongoing resource management and the upcoming development of a Site Management Plan. The overall approach is to link biological inventory and monitoring information to site management alternatives. As such, this report serves as a blueprint to inform the complex recreation and resource management decisions that will arise in the short- and long-term. Specific scope items included: vegetation inventory, wildlife surveys, recreation and resource management evaluation, biological impact assessment report preparation, development of graphic materials, and recommended monitoring protocols.

This assessment process builds upon the 2012 Boulder Reservoir Master Plan and previous reservoir management information developed over the past 30 years including:

- Boulder Reservoir Development Master Plan (Design Studios West Inc. Shapins/Moss. 1983)
- Boulder Reservoir Environmental Study and Final Report, (Camp Dresser & McKee 1986)
- Prairie dog census information from 1996-2013
- Wetland mapping and functional evaluation, 1998 and 2004
- Noxious weed management, 2001-2013
- Bird surveys, 2004-2013
- City of Boulder Urban Wildlife Management Plan—Black-Tailed Prairie Dog Component, 2006
- 2009 Reservoir User Survey
- City of Boulder Parks and Recreation Urban Resources, Three-Year Management Plan (2011-2013), 2011
- Biological Species Analysis ERO Report, February 2013
- Field crew logs of wildlife sightings

The current assessment process integrates relevant existing information and 2013 inventory results to create a comprehensive framework. This approach is based on established conservation planning methods, current literature and research including recreation theory, monitoring and adaptive management principles, and our experience with a wide range of ecosystems throughout Colorado and the country. Specifically, this framework is based on a Conservation Action Planning approach (The Nature Conservancy, 2007) as well as guidance and planning documents provided by Colorado Natural Heritage Program (2005) and the City of Boulder Open Space and Mountain Parks (2010). Briefly, the Conservation Action Planning approach includes:

- 1) identifying conservation priorities or “targets;”
- 2) assessing the current quality and long-term viability of the conservation targets based on size, context, and condition;
- 3) identifying the threats to the conservation targets and the sources of the threats;
- 4) developing strategies to address the threats, and;
- 5) establishing a monitoring program to measure success of implemented actions and the need for possible modifications.

1.3 Report Organization

This remainder of the document is organized as follows:

Section 2 – Physical Setting and Current Management briefly describes the site context in terms of landscape, topography, climate, geology, water resources, soils, current management practices, and ecological management zones;

Section 3 – Vegetation Inventory Results presents a summary of the plant field surveys conducted in 2013 and highlights conservation priorities;

Section 4 – Wildlife Inventory Results presents a summary of the wildlife surveys from 2013 and highlights conservation priorities;

Section 5 – Recreation and Resource Management Evaluation establishes the framework for natural resource conservation, identifies impacts associated with recreational activities, discusses carrying capacity considerations, and identifies compatibilities of certain uses;

Section 6 – Management Options and Priorities includes a matrix of management goals and objectives, and;

Section 7 – Monitoring Protocol recommends a program for collecting information that will support an adaptive approach to future management.

References, Report Preparers, and Appendices include additional project details including wildlife and plant species information, zone maps and details about inventory methods and criteria for ecological condition.

The information provided in this report is intended to provide ecological and resource management information that can be folded easily into the city’s forthcoming Site Management Plan.

2. PHYSICAL SETTING AND CURRENT MANAGEMENT

Biological resources of the Reservoir are directly related to the landscape context and the physical resources of the site. Key factors, such as topography, climate, geology, water resources, and soils interact to provide primary control of ecosystems. Human activities such as water diversions, development, and transportation provide additional influences through disturbances and management practices.

2.1. Landscape Context

Boulder Reservoir is located near the northern city limits, between 51st and 63rd Street, and northwest of Highway 119 (Figure 1). Nearby and adjacent properties include City of Boulder Open Space and Mountain Parks and private properties to the north and west, Tom Watson Park to the northeast, Six-Mile Reservoir to the south, and industrial and commercial properties to the east. The topography of the property generally slopes downward to the east, and elevations range from approximately 5,280 ft at the western edge to 5,140 ft near the eastern boundary. The water elevation of the Reservoir itself varies annually, but Northern Colorado Water Conservancy District manages for a *high* water elevation of 5,183 ft.

Ecoregions refer to areas with similar characteristics based on factors such as geology, soils, vegetation, and hydrology. Ecoregional boundaries are approximate, and ecoregion maps use a variety of classifications at different scales. The City of Boulder is located in the Temperate Steppe Division of the Dry Domain part of the United States (Bailey *et al.* 1994). Within these larger systems, Boulder is located in a transition zone between two ecoregions—the Rocky Mountains to the west and the Great Plains to the east—and the Reservoir is located in the Front Range Fans subregion (Figure 2). It is generally recognized that there tends to be high biodiversity in areas where ecoregions come together (like near Boulder), because there is potential for movement across a broader range of habitat types.

2.2 Climate

Colorado's climate affects the availability of water resources and vegetation patterns. Precipitation varies significantly from year to year and at different elevations across the state. High snowfalls occur in the mountains in the winter, and snow melt in the spring feeds creeks that supply water to lower elevations where precipitation is much less. The Western Regional Climate Center (WRCC) data for the period from 1981 to 2010 reports the mean temperatures in Boulder ranged from 33.3°F in December to 72.5°F in July. WRCC reports that average annual precipitation for this same period was 20.7 inches. During the recent drought years of the early 2000s, precipitation in Boulder was well below average, with only 13.8 inches reported total for 2002, the lowest amount on record since 1977 (CWI, 2013). Annual precipitation in 2012, prior to the biological assessment, was 15.7 inches, well below average, while 2013 had above average precipitation of 34.2 inches (NOAA, 2014).

2.3 Surface Water Features

The Reservoir was built between 1938 and 1957 by the Northern Water Conservancy District for storage and delivery of water from the Colorado Big-Thompson project. The current Reservoir capacity is 13,100 acre-feet. The Boulder Feeder Canal supplies the water at the north end of the Reservoir¹. According to information collected by the Northern Colorado Water Conservancy District from 1995-2011, annual water surface elevation fluctuations ranged from 2 ft in 2007 to over 18 ft in 1996, with an average annual fluctuation of about 8 ft. Details of the Reservoir development and management are provided in the Master Plan (2012) and other historical documents (referenced in Section 1.2).

The Reservoir is located in the eastern portion of the St. Vrain Watershed, in the Boulder Reservoir sub-basin (Figure 3). Surface water in the area generally drains eastward via creeks that bisect the foothill fans. Dry Creek is the major drainageway that enters the Reservoir from the west, exits from the east side of the north dam, and continues flowing downstream for about 10 miles until its confluence with St. Vrain Creek. Little Dry Creek is the second significant drainage, located roughly

¹ City water quality staff also note that during the Fall 2013 September flood event, the reservoir received water from the St. Vrain River, Lefthand Creek, and possibly the western slope via the Boulder Feeder Canal on the north side of the reservoir.

parallel to and south of Dry Creek: it drains from the west and terminates in the Reservoir. Both of these drainages provide physical and hydrologic connectivity to upstream protected areas in the west.

Small reservoirs are located offsite, in the upper portions of both of Dry and Little Dry Creeks. These features have likely altered the flow conditions in the creeks by trapping sediments and collecting water that would have otherwise flowed downstream during droughts and low flow periods. In addition to the primary tributaries, there is a small, unnamed, intermittent drainage that periodically discharges into the southwest corner of the Reservoir.

2.4 Geology

Figure 4 shows the geologic features of the property. The main portion of the Reservoir is underlain by Pierre Shale bedrock deposits (Cretaceous Period, 65-144 Mya). Slocum Alluvium (Quaternary Period, mid-late Pleistocene, 1.8-2 Mya,) is present beneath the upland areas to the north and west, and is characterized as “10 to 90 ft of moderate reddish-brown, well-stratified, clayey coarse sand with lenticular beds of pebbles and silt” (Moore et al, 2001). Piney Creek Alluvium (Holocene, <4,000 yrs ago) is present in relatively narrow bands in the Dry Creek and Little Dry Creek drainages to the west. Piney Creek alluvial deposits consist of poorly sorted, coarse sands and gravels.

2.5 Groundwater

Groundwater occurs in the vicinity of the Reservoir in an unconfined sand and gravel aquifer (sometimes called a water table aquifer). Because groundwater may support baseflow and vegetation in the riparian areas along the creeks, understanding and maintaining groundwater hydrology can be important for long-term viability of these ecosystems. In unconfined systems, precipitation infiltrates in upland areas to recharge groundwater, and the groundwater moves through the subsurface generally following the topography, until it reaches discharge points. Groundwater discharge occurs where the aquifer intersects ground surface, and water is released into seeps or springs that feed into lakes, streams, and wetlands. Water table aquifers will fluctuate up and down with seasonal and annual climate variations. In the Front Range, the water table generally rises in the winter, peaks after spring snowmelt, and is followed by a steady decrease throughout the growing season. Droughts and human water management practices (e.g., diversion ditches, wells, sump pumps, and storm sewers) can cause significant long-term changes in the water table.

In the vicinity of the Reservoir, groundwater generally flows to the east off of the foothill fans and discharges into the alluvial sand and gravel deposits along the creeks. (Refer to Figure 4.) The uplands to the west of the Reservoir may not be saturated year round, but localized water tables may occur in areas with seasonal saturation (Hillier and Schneider, 1979). The underlying Pierre Shale is relatively impermeable, so the bedrock acts as a lower boundary to the aquifer. In addition to the natural flow paths, localized mounding of groundwater from the Reservoir also likely occurs, i.e., where radial flow to the west probably helps to maintain water in the Piney Creek alluvium along the drainageways.

2.6 Soils

Eleven soil types have been mapped on the Reservoir property by the U.S. Department of Agriculture, Natural Resources Conservation Service (see Figure 5). The majority of the soils are characterized as clay dominated (two are clay, five are clay loam, and two are silty clay loam). The most common soil types found on the property are Longmont clay, 0-3% slopes (LoB) and Samsil-Shingle complex, 5-25% slopes (SeE) as described in more detail below.

Longmont Clay(LoB) comprises 33% of the soils at the Reservoir, and it is found along the drainages and in the southeast corner of the property. It is characterized as poorly drained soil that forms on shale residuum. Native vegetation potentially supported by this soil type include: alkali sacaton, switchgrass, western wheatgrass, Nebraska sedge, little bluestem, prairie cordgrass, Nuttall’s alkaligrass, alkalibluegrass, alkali cordgrass, big bluestem, inland saltgrass, rush.

Samsil-Shingle complex, 5-25% slopes (SeE) also covers 33% of the property and is primarily on the foothill sideslopes and the north shore. The Samsil soil series consists of shallow, well-drained soils formed on hills and ridges in residuum from

weathered shale. Native shortgrass prairie species found on this soil are needlegrass, western wheatgrass, and needle and thread.

The remaining soils that comprise 27% of the site include the Renohill silty clay loam, 1 to 3 percent slopes (RnB) and 3 to 9 percent slopes (RnD) found along the south shore and the Valmont series soils around Coot Lake (clay loams, VaB and VaB, and cobble clay loam, VcC) found.

2.7 Summary of Current Management

Boulder Reservoir has been a popular recreation area since the mid 1950s, and most of the City Parks and Recreation Department management efforts relate to recreation. Currently, the Reservoir is a regional recreational attraction for 300,000 visits per year. Visitors travel from the greater Denver and Boulder metropolitan areas (City of Boulder, 2009) as well as from out-of-state visitors e.g., who may stop over on their way to Rocky Mountain National Park. A wide range of passive and active recreational activities occur at the Reservoir including hiking and dog walking, boating, fishing, swimming and wading, jogging, biking, picnicking and community events. The 2012 Master Plan summarized the varying recreational uses and activities, and Figure 6 presents the locations of major visitor features.

Reservoir access is provided via three main points – the Southern Entry Gate, Coot Lake Trailhead, and the northwest parking area at 55th Street. Most visitors arrive by car, and the main parking area is in the South Shore (1144 standard parking and 1700 overflow spaces). Trails are located primarily on the south, east, and north sides of the Reservoir. The Parks and Recreation Department has mapped 3.7 miles of primary, multi-use trails with another three miles of secondary, social trails. Coot Lake and the North Shore are popular areas for dog walkers. Wildlife closures are implemented on the west side of the Reservoir and the western wetlands at Coot Lake.

Currently, three full-time Parks and Recreation Department staff members are employed at the Reservoir – a Manager, Assistant Manager, and Program Coordinator. Together, they are responsible for myriad activities including managing community events, equipment maintenance (e.g., for the boat and vehicle fleets), front gate oversight, lake patrol and water safety, landscape and irrigation, oversight and coordination of project improvements, aquatic nuisance species education, picnics and camps, and training of seasonal staff. The level of effort varies seasonally, and during peak periods from June to September, over 60 seasonal employees play key roles to assist with operations and activities such as beach safety, lake patrols, entrance gate operations, and special events. Note that current responsibilities of the staff at the Reservoir are not directly related to maintaining and improving the natural resources described herein.

In addition to the full-time Reservoir staff, the City of Boulder's Integrated Pest Management (IPM) and Conservation crew spends a portion of their time conducting maintenance at the Reservoir that includes noxious weed control, reseeding, Russian-olive removal and tree replacement, Prairie Dog counts and mapping, Prairie Dog barrier repair, interpretive signage, and trail and facilities around Coot Lake (i.e., restrooms, trash, and picnic tables). City of Boulder Public Works water treatment staff also collects water samples in the Reservoir on a monthly basis. Samples are collected from both tributaries, the feeder canal, and the intake structure and analyzed for general water quality parameters. The Colorado Department of Health and Environment (CDPHE) also collects water quality samples from the swimming area at least twice per week, and CDPHE is responsible for instituting beach closures.

2.8 Ecological Management Zones

The information described in the preceding subsections was used to refine the Management Zones from the Master Plan and create Ecological Management Zones based on areas with similar physical and biological conditions. Note, preliminary boundaries were used during the inventory process and then further refined based on observations and information gathered about vegetation communities. Figure 7 presents the Ecological Management Zones that will assist with planning future management and monitoring of biological resources at the Reservoir.

3 VEGETATION INVENTORY RESULTS

Plant community mapping was completed in June 2013 to assist with developing management strategies at Boulder Reservoir (see Figure 8). Key objectives of the mapping were to identify native and non-native plant communities, to inventory dominant species of each community type, and to note the presence of any Boulder County Noxious Weeds. The City of Boulder Open Space and Mountain Parks' (OSMP) Grassland Ecosystem Management Plan was used as a reference for defining the Boulder Reservoir plant communities. As shown in Table 1, four native communities were identified -- Mixed Grass Native Prairie, Native Riparian, Herbaceous Wetland, and Woody Wetland -- along with Non-Native Riparian, Non-Native Upland, and an "Other" category for areas of development, large areas of bare ground, salt flats, and living fences.

Table 1 Plant Communities at Boulder Reservoir and Observed Dominant Species*

Plant Community	Plant Community Classification Criteria	Basis in OSMP Grassland Ecosystem Management Plan	Dominant Species Observed in 2013	Major Differences Between Expected and Observed Plant Community Characteristics
Mixed Grass Prairie Mosaic	Native species relative cover >60%. Most prevalent native species to include western wheatgrass, blue grama, silver sage, Junegrass, buffalograss, snakeweed, scurfpea.	Mixed Grass Prairie Mosaic.	Native western wheatgrass most common. Occasionally-observed dominants included native species blue grama, needle-and-thread, purple three-awn, yucca, fourwing saltbush, silver sage, snakeweed, scurfpea.	Western wheatgrass more prevalent than other native species, overall diversity fair.
Native Riparian	Cottonwoods (plains, lanceleaf, narrowleaf) > 50% including plains, lanceleaf, and narrowleaf cottonwoods; box elder; shrubs, <i>e.g.</i> , snowberry, hawthorn, Woods' rose, plum, and grape; native herbaceous understories.	Riparian areas.	Native plains cottonwood most common. Occasionally observed dominants included native peach-leaved and sandbar willow and non-native Russian-olive.	Plains cottonwood more prevalent than other native species. Native understory often not well-developed.
Herbaceous Wetland	Narrow-leafed cattail, bulrush, sedges, rushes, swamp bluegrass, milkweed, sedges, and grasses (foxtail barley, switchgrass, alkali muhly). Dominant species may include non-natives.	Emergent wetlands and wet meadows.	Cattails and native rushes most common. Occasionally observed native dominants included swamp bluegrass, bulrush, sedges. Non-native dominants included teasel and reed canarygrass.	Extensive monocultures of teasel and cattail observed. Low native diversity.
Woody Wetland	Sandbar willow, peach-leaved willow, leadplant. Cattail (both native and non-native), native arctic rush. Includes minor non-native tamarisk.	Riparian wetlands.	Native sandbar willow most common with occasional native peach-leaved willow.	Observations consistent with expectations, except no tamarisk found.
Non-native upland	Any of prairie types with >40% non-native pasture grasses, <i>e.g.</i> , smooth brome, orchardgrass, quackgrass, bluegrass, non-native wheatgrasses, upland weeds & forbs.	Not a category.	Smooth brome most common. Frequently observed species included bindweed, cheatgrass, Japanese brome, horehound, Canada thistle, alyssum (all non-native).	Observations consistent with expectations.
Nonnative Riparian	Non-natives Russian-olive, tamarisk.		Non-natives Russian-olive and white poplar most common. Native willows species and cottonwoods were frequent associates.	Native associates were observed.

*Refer to Appendix A for list of other plant species found on site.

In addition to these community types, we surveyed the Reservoir for Xeric Tallgrass and Mesic Bluestem communities, both of which are dominated by big bluestem and have been found on OSMP grassland properties. However, no big bluestem plants were observed at the Reservoir during the field surveys, so these community types were not included in the 2013 inventory. High-resolution aerial photographs were used in the field to draw plant communities, and the polygons were then digitized using Geographic Information System (GIS). The smallest mapping unit for a polygon was approximately ~0.1 acre (~4,000 sq ft). Generally, two to three dominant/sub-dominant species were recorded for each polygon. Dominant and sub-dominant species were defined as having at least 25% cover, with “dominant” species having the largest area of cover. If species had approximately equal coverage they were designated “subdominant.”

Table 2 summarizes the plant community inventory at the Reservoir by ecological management zone, and the zones listed from left to right are in order of highest to lowest acres of native plant communities. Of the approximately 704 acres mapped at the Reservoir², one-third is comprised of native plant communities. Herbaceous wetland is the largest native plant community, and nearly 80% of these wetlands occur in the Dry Creek and Little Dry Creek areas. Descriptions of each of the plant communities are provided in the following subsections.

Table 2 Summary of Plant Community Types by Ecological Management Zone (acres)

	Dry Creek	Little Dry Creek	Coot Lake Wetlands	South Dam	North Dam	Western Uplands	North Shore	South Shore	Total	%
Native Plant Communities										
Mixed Grass Native Prairie	30.5	18.5	1.3	21.0	2.2	8.2	6.2	0.0	87.9	12%
Native Riparian	4.2	5.7	4.0	0.0	5.1	0.0	2.9	0.0	21.9	3%
Wetland Herbaceous	47.0	42.0	12.8	1.9	4.9	4.6	1.5	0.9	115.5	16%
Woody Wetland	2.8	2.5	0.9	0.0	0.0	0.0	1.3	1.8	9.3	1%
Native Plant Communities Subtotal	84.4	68.8	19.1	22.8	12.2	12.8	11.8	2.7	234.6	33%
(% of Zone)	(63%)	(71%)	(32%)	(23%)	(14%)	(13%)	(21%)	(2%)		
Non-Native Plant Communities										
Non-Native Riparian	0.0	0.0	1.3	0	0.3	0.0	0.1	0.0	1.7	0.2%
Non-Native Upland	34.7	15.8	7.1	33.0	60.0	81.3	36.2	0.0	268.2	38%
Non-Native Subtotal	34.7	15.8	8.4	33.0	60.3	81.3	36.3	0.0	269.9	39%
(% of Zone)	(26%)	(16%)	(14%)	(34%)	(71%)	(82%)	(64%)	(0%)		
Other										
Bare ground, shore, trails, developed park, etc.	14.0	12.7	1.5	42.4	12.1	5.0	8.6	73.0	169.3	24%
Open Water	0.0	0.0	30.4	0.0	0.0	0.0	0.0	0.0	30.4	4%
Totals (Rounded)	133	97	59	98	85	99	57	76	704.1	100%

² The reported acreage of land around the reservoir varies in different sources and appears to depend on water levels and the extent that auxiliary properties such as the fire training center are included.

Appendix A provides additional vegetation information including detailed vegetation maps for each ecological zone with a list of observed dominant plant species. Descriptions of key findings for each of the plant communities are provided in the following subsections.

3.1 Mixed Grass Native Prairie

Mixed Grass Native Prairie comprises 12% of the survey area and is mainly present in areas of Samsil-Shingle complex, an upland soil type with high erodibility. Although most prevalent on the western side of the study area, Mixed Grass Native Prairie communities were present in all of the Management Zones except the South Shore. Patch size ranges from 0.5 to 25 acres (with the largest occurring in the Dry Creek area).

In nearly all of the Mixed Grass Native Prairie polygons, western wheatgrass is a dominant species and often the sole dominant forming a near monoculture (Photograph 1). Other native species occasionally observed as dominants included blue grama, needle-and-thread, purple three-awn, fourwing saltbush, yucca, silver sage, snakeweed, and slimflower scurfpea. Non-native dominant species included cheatgrass, crested wheatgrass, smooth brome, bindweed, and horehound. Noxious weeds included Canada thistle, bull thistle, and knapweed. In most cases bare ground was not a major feature.



Photograph 1. Western wheatgrass-dominated community north of the Reservoir. Note patches of smooth brome.

Frequently, Mixed Grass Native Prairie is found adjacent to Non-native Uplands. Encroachment of non-native species such as smooth brome into the native Mixed Grass Native Prairie community was frequently observed and thus these two community types are often found adjacent to each other. This encroachment of non-native communities into native-dominated communities and is expected to continue in the absence of management efforts.

Disturbances by prairie dogs, which are present in some of the Mixed Grass Native Prairie communities and prevalent in several Non-native Upland communities, and recreational users could accelerate this transition.

3.2 Herbaceous Wetlands

Herbaceous Wetlands-- including wet meadows and emergent wetlands³--represent almost 16% of the survey area and occur in every Management Zone. Herbaceous wetlands are mainly associated with Longmont Clay soils, a soil type that is deep and poorly drained, or with the former borrow pit area of Coot Lake. Patch sizes of Herbaceous Wetlands



Photograph 2. Mosaic of emergent and woody wetlands with open water at Coot Lake.

³ "Emergent wetlands" based on Cowardin et al "Classification of Wetlands and Deepwater Habitats of the United States"

at Boulder Reservoir range from <1 acre to >20 acres (in Dry Creek). Coot Lake, Dry Creek and Little Dry Creek each have one or more large patches of approximately 10 acres.

Occurring along drainages and in low-lying areas, the soils of Herbaceous Wetlands are saturated during all or a significant portion of the growing season. The largest Herbaceous Wetland communities are associated with the riparian areas of Dry Creek and Little Dry Creek and with low-lying areas adjacent to the shoreline. The Coot Lake area supports Herbaceous Wetlands in a mosaic with open water, woody wetlands, and riparian areas (Photograph 2).

Cattail and rushes were the most commonly observed dominant native species, with secondary occurrences of swamp bluegrass and sedges (Photograph 3). It was not uncommon for teasel to form a monoculture (Photographs 4). Isolated woody species including cottonwood, peach-leaved willow and non-native crack willow were also observed.



Photographs 3 and 4. Native-dominated (left) and nonnative-dominated (right) herbaceous wetlands. The arctic rush-dominated area on the left is in the Little Dry Creek management zone. The teasel-dominated area shown on the right is in the Dry Creek management zone.

Note, the Herbaceous Wetland category included patches of teasel (which is typically ranked as facultative upland) because it is very frequently an indicator of drying wetlands, and at the Reservoir these areas were previously wetter and could revert to saturated soils (i.e., following the high precipitation events of 2013).⁴

3.2 Woody Wetlands

Woody Wetlands comprise 1% of the survey area, the relatively small number of patches ranging from 0.1 to 1.8 acres in size. Woody Wetlands are found predominantly along the west and north shores of the Reservoir and in the Coot Lake area. Each Management Zone between Little Dry Creek and Coot Lake supported at least one Woody Wetland community.



Photograph 5. Sandbar willow dominated woody wetland in the northwest corner of the Coot Lake complex.

⁴ More detailed wetland delineations would be needed to refine the current mapping to segregate patches of teasel; however, given the uncertainty and fluctuations in hydrologic conditions, such delineations were beyond the scope of the current effort or project needs.

Some Woody Wetlands are associated with Herbaceous Wetlands or upslope of drainage. Like the Herbaceous wetlands, the woody wetland communities are associated with Longmont clay soils and the borrow pit area of Coot Lake. Similar to other woody wetlands of the Boulder County area, Woody Wetlands are dominated primarily by native sandbar willow and occasionally by peach-leaved willow. The understory is typically very sparse.

3.4 Native Riparian

Native riparian communities, comprising 3% of the survey area, are wooded areas with sufficient soil moisture to support trees and shrubs, and they are most commonly located between the permanently saturated area adjacent to impounded water and the higher upland areas. In general, shorelines and other hydrological boundaries are along low-gradient slopes (Photograph 6). At Coot Lake and around Dry Creek, the riparian communities form a mosaic with wetland communities. This community is primarily associated with the shallow soils of the Samsil-Shingle complex. The size of Native Riparian

patches range from 0.1 to about 4.7 acres.

Plains cottonwood is the dominant species in all Native Riparian communities of the study area. Overstory co-dominants include native peach-leaved willow and sandbar willow as well as non-native Russian -olive. Herbaceous understory species, when present, are dominated by non-native smooth brome with occasional native rush species.

3.5 Non- Native Riparian

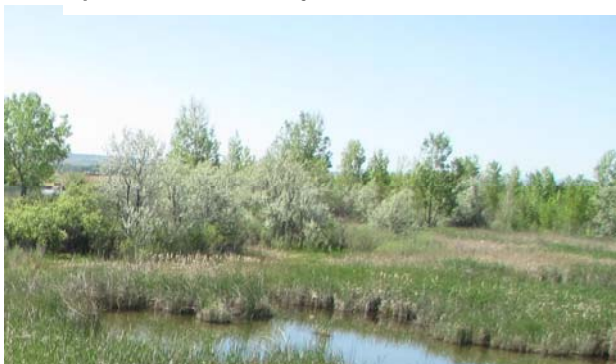
Non-native riparian communities primarily occurred in the Coot Lake vicinity, covering 0.2% of the total survey area and in small areas in the North Dam and Western Uplands. The patch sizes are generally small and range from 0.1-0.4 acres. The Russian-olive dominated non-native riparian communities are associated with the borrow pit soils of the Coot Lake area, and the white poplar communities are associated with Valmont cobbly clay loam which formed on terraces. Most polygons were dominated by Russian-olive with subdominant occurrences of plains cottonwood or peach-leaved willow (Photograph 7). Two polygons south of Coot Lake were dominated by white poplar with a smooth brome or sandbar willow understory.

3.6 Non-Native Uplands

Non-native upland comprises 38% of the survey area and is represented in all management zones. Patch size distributions are roughly 33% <10 acres, 42% 10-20 acres, and 25% >25acres (the latter is just two polygons -- a 25-acre patch in the Western Uplands and a 40-acre patch in the north dam area. The most common species is smooth brome; bindweed is also widespread. Other commonly observed non-native species included cheatgrass, Canada thistle, horehound, Japanese



Photograph 6. Native riparian band dominated by plains cottonwood adjacent to north shore of the



Photograph 7. Russian-olive dominated non-native riparian area in foreground



Photograph 8. Example of non-native upland community located in the North Dam Ecological Management Zone .

brome, crested wheatgrass, alyssum, and tall wheatgrass (Photograph 8). This community type was most prevalent on Samsil-Shingle complex soil, but was also observed on other upland soil types. Patches of native western wheatgrass were occasionally present within the non-native community. Very weedy non-native upland areas appear to be encroaching into mixed-grass native prairie upland areas.

3.7 "Other" Category

The "Other" Category mainly includes large areas of structures such as roads, dams, riprap dam faces, and recreational facilities such as parking lots, buildings, and a model airport. Secondly, this category included areas with greater than 50% bare ground such as shorelines and associated mudflats as well as other small areas of infrequently encountered vegetation types such as salt flats and living fences. Of these, the mudflats and salt flats have ecological value because they provide critical forage for shorebirds, especially during late summer/early fall when water drawdown for irrigation and from evaporation exposes more of this substrate. Shorebirds observed at the reservoir that may use mudflat ecotypes include killdeer, American avocets, spotted sandpipers, Wilson's snipe, and Wilson's phalarope.

Salt flats are wetlands that form soils with high soil salt concentrations and a shallow water table. A seasonally high water table brings the salts to the surface or soil capillary fringe. All salt flats are located within Longmont clay soils, a soil type described as "poorly drained salty and alkaline." Vegetation is typically herbaceous and limited to halophytes that form distinctive plant communities (Photograph 9). During the time of the 2013 field assessment, salt flat vegetation was very sparse, and the areas could be easily distinguished by the precipitated soil salts on the surface. Species present included sea-blite and sand spurrey. The largest salt flats occurred in areas below the Boulder Reservoir dams (with two acres in the North Dam area and four acres in the South Dam areas); small salt flat areas also occurred along the western shoreline of the Reservoir. At present, four bird species may meet habitat requirements in or around the salt flats. Vesper sparrows may use the area for nesting, red-winged and yellow-headed blackbirds could find foraging opportunities, and killdeer are also known to utilize areas such as these salt flats. Further research is recommended to document the species and conditions at these uncommon wetlands.



Photograph 9. Example of salt flat in Dam areas west of 63rd Street.



Photograph 10. Living fence between the south dam and the Fire Training Center.

Living fences are rows of planted deciduous and evergreen woody species that can serve as windbreaks and/or visual barriers. In the study area, living fences are located in the area between the south dam and the Fire Training Center and the South Dam (Photograph 10) and along the south edge of the Little Dry Creek Management Zone.

3.8 Noxious Weeds

The 2013 vegetation inventory included observations of noxious weeds but did not include a comprehensive weed survey. Table 3 lists 23 noxious weeds, eight of which were identified during the June 2013 field surveys and the remainder from the Three-Year Management Plan produced by the city's Integrated Pest Management and Conservation Crew (City of Boulder

Parks and Recreation Department, 2011). The Management Plan specified which non-natives had been observed in different “Natural Areas” at the Reservoir (which roughly correspond to the Management Zones in this document) and prescribed management efforts and/or monitoring for the ensuing three growing seasons.

Table 3 Priority Noxious Weeds and Priorities at Boulder Reservoir

Species	State class	Weed locations based on Historic IPM Control Reports ¹	Locations where observed in 2013 ²
Priority Species for Eradication			
Purple Loosestrife	A	Aeromodel ³ , Coot Lake Wetland, Little Dry Creek ³ , North Dam, North Shore, Windsurfer's	[Note, purple Loosestrife blooms in late June to early July after the time of the inventory.]
Mediterranean sage	A	Aeromodel, Coot Lake Wetland (uplands, few plants in 2009 & 2013), Little Dry Creek, North Dam, North Shore, Reservoir Main Entrance, South Dam, Windsurfer's Point	
Myrtle Spurge	A	Little Dry Creek (single plant in 2005), North Dam (single plant in 2012), Reservoir Main Entrance (single plant in 2011, three plants in 2012)	
Bouncingbet	B(e)	Reservoir Main Entrance (Few plants), Windsurfer's Point	
Oxeye Daisy	B(e)	Coot Lake Wetland	
Spotted Knapweed	B(e)	Coot Lake Wetland, South Dam	Little Dry Creek
Yellow Toadflax	B(e)	Aeromodel, Coot Lake Wetland, Little Dry Creek, North Shore, South Dam	
Priority Species for Containment and Suppression			
Bull Thistle	B(s)	Coot Lake Wetland, North Shore	Dry Creek, Little Dry Creek, South Dam, Western Uplands
Dalmatian Toadflax	B(s)	Aeromodel, Little Dry Creek, North Dam, South Dam	
Diffuse Knapweed	B(s)	Coot Lake Wetland, Little Dry Creek, North Shore, North Dam, South Dam, Windsurfer's Point	
Houndstongue	B(s)	Coot Lake Wetland, Little Dry Creek, North Shore, South Dam, Windsurfer's Point	
Musk Thistle	B(s)	Aeromodel, Coot Lake Wetland, Little Dry Creek, North Dam, North Shore, South Dam, Windsurfer's Point	Dry Creek, Coot Lake
Perennial Pepperweed	B(s)	Aeromodel, Little Dry Creek, North Shore, South Dam, Windsurfer's Point	
Scotch thistle	B(s)		
Teasel	B(s)	Aeromodel, Little Dry Creek, North Dam, North Shore, Reservoir Main Entrance, South Dam, Windsurfer's Point	Coot Lake, Dry Creek, Little Dry Creek, North Dam, North Shore, South Dam, South Shore, Western Uplands
White Top	B(s)	Coot Lake Wetland	
Russian Olive	B	Aeromodel, Coot Lake Wetland, Little Dry Creek, North Dam, North Shore, South Dam, Windsurfer's Point	Coot Lake, Dry Creek, Little Dry Creek, North Shore
Tamarisk	B	Aeromodel (controlled 2008-2013), Coot Lake Wetland, North Shore (previously controlled), Windsurfer's Point	
Additional Priority Species in City IPM Plan			
Canada Thistle	B	Aeromodel, Coot Lake Wetland, Little Dry Creek, North Dam, North Shore, Reservoir Main Entrance, South Dam, Windsurfer's Point	Dry Creek, Little Dry Creek, South Dam, Western Uplands
Quackgrass	B	Coot Lake Wetland	
Chicory	C	Coot Lake Wetland	
Mullein	C	Aeromodel, Coot Lake Wetland, North Dam, North Shore, South Dam	Western Uplands
Perennial Sow thistle	C	Coot Lake Wetland, Little Dry Creek,	

¹ Historic information is not intended to be an all inclusive inventory, rather it is based upon observations collected during control. Also note, Aeromodel or formerly “The Anthill” is the name for the Dry Creek area in the 2011 IPM plan “Windsurfer” refers to the Little Dry Creek area.

² Observations are representative snapshot for early June and were not intended to be comprehensive weed survey.

³ IPM crew notes that a native loosestrife is also present in Little Dry Creek and needs to be distinguished prior to treatment.

As indicated in Table 3, the June 2013 inventory observed the presence of eight of the species listed in the 2011 IPM Plan. This is likely because the current inventory was a limited snapshot conducted in June, which is relatively early in the Colorado growing season and many of these species are better identified later in the season.

3.9 Plant Species of Concern

As part of the 2013 vegetation mapping effort, qualitative observations were conducted of areas of potential habitat for Fish and Wildlife Service Listed Species for plains areas of Boulder County, anticipated to include Ute ladies'-tresses orchid, Colorado butterfly plant, and Bell's twinpod.

Ute ladies'-tresses orchid typically occurs in open areas that have high water table and alluvial deposit soils, and are adjacent to perennial streams. Typical associate plants are horsetail, swamp milkweed, and blue vervain. Due to lack of appropriate habitat, Ute ladies'-tresses orchid is very unlikely to be present at Boulder Reservoir.

Colorado butterfly plant typically occurs in sub-irrigated, alluvial soils of drainage bottoms surrounded by mixed grass prairie. Habitat for Colorado butterfly plant is marginal at Boulder Reservoir. However, we recommend a growing season survey for this species.

Bell's twinpod is restricted to limestone and calcareous shales of the Niobrara formation which is not present within the Boulder Reservoir area. However since Pierre shale is present and may also provide habitat, we recommend a growing season survey for this species.

Boulder County identifies several other species of concern and plant communities in addition to the federal species of concern discussed above. Specifically, the Boulder County Comprehensive Plan identifies an area on the northwest side of the Reservoir as a Rare Plant Area; however, detailed information on locations and species are not public record (to protect the plants.)

3.10 Summary of Findings from Vegetation Inventory

The 2013 inventory confirmed that the Boulder Reservoir management area is comprised of a combination of native plant communities, non-native plant communities, and areas designated as "Other." Native plant communities total about 234 acres and are located primarily in Dry Creek and Little Dry Creek zones as well as the Coot Lake and South Dam areas. The most ecologically significant vegetation communities of the Boulder Reservoir are the large areas of native herbaceous wetland, the remnant areas of mixed grass native prairie, and the uncommon salt flat areas (included in the mapping category designated "Other"). These areas are important due to their extent, high proportion of native species, and/or their relative lack of disturbance. The rare plant area identified on the northwest side of the Reservoir in the Boulder County Comprehensive Plan is another area of important ecological significance. Key characteristics of native plant community are listed below.

- The largest wetlands, both herbaceous and woody, are present in areas of high water table supplied by proximity to impounded water and/or to natural drainages. These areas are primarily adjacent to Dry Creek, Little Dry Creek, an unnamed drainage south of Little Dry Creek, and Coot Lake. Smaller wetland areas are associated with low areas adjacent to Boulder Reservoir; hillslope seeps west of 55th Street; ditches, including outlets from Boulder Reservoir and Coot Lake; and the low-lying areas below both the north and south dams. Although the most common dominant species was cattail, it is important to note that some wetlands contain infrequently encountered large areas of native rush communities. Arctic rush in particular has a wide ecological amplitude and, though often indicative of moister soils, can also occur in drier areas. For woody wetlands, the dominant species was sandbar willow, the typical dominant of woody wetlands in the plains areas to the east of the Colorado Front Range. Several clusters of woody wetland within large herbaceous wetlands were dominated by peach-leaved willow. In many woody wetlands,

plains cottonwoods were occasionally present as were Russian-olive. Salt flat wetlands would benefit from a detailed study of species and hydrology as well as control of non-native vegetation.

- The largest patches of Mixed Grass Native Prairie are present on the west side of the Reservoir and to the northeast of the Fire Training Center. Smaller patches are intermittently present throughout the study area and are nearly always adjacent to non-native uplands. Although western wheatgrass is a very frequent dominant species, many areas contain a variety of native grasses and forbs as well as shrubs and sub-shrubs such as four-wing saltbush and yucca.
- Riparian areas, both native and non-native, are present in clusters within and at the edges of herbaceous wetlands and along the shoreline of Boulder Reservoir. By far the most frequently encountered species was plains cottonwood, although peach-leaved and sandbar willows and Russian-olive are also occasionally present. Many riparian areas lack a well-developed understory. In areas with an understory, smooth brome was the most common species.

The encroachment of non-native species into areas of native vegetation is a major concern identified during the 2013 Reservoir survey, though it is not unexpected given that it is a common problem of the plains area of Boulder County. The cause of the weediness varies. For example, the drying of wetland soils probably has contributed to the establishment of large stands of teasel in Herbaceous Wetlands. The development of patches of bindweed, smooth brome, and/or cheatgrass in Mixed Grass Native Prairie communities may be exacerbated by the increased occurrence of social trails with increased visitor use. The drawdown zone of Boulder Reservoir develops sparse vegetation during times of low water levels, presenting an opportunity for sandbar willow and cottonwood, but also for tamarisk, which is difficult to eradicate. OSMP staff note that one year an exotic annual grass, foxtail prickleglass, was observed to carpet the mudflats during the low water period (M.Gershman, personal communication, 2013)

Most of the plant communities, such as the monocultures of western wheatgrass in Mixed Grass Native Prairie, would benefit from increased diversity of native species to improve wildlife habitat and to increase their adaptability to future pressures such as climate change. Native riparian and woody wetland communities would benefit from removal of non-native Russian-olive and establishing a native understory, although understory establishment would likely prove difficult despite its ecological value.

Connectivity of vegetation communities, including habitat connections to adjacent properties (Figure 9), is another issue of concern for the Parks Department to manage and monitor. In general, wildlife connectivity is greater among native plant communities than between a native and a non-native community. This is because native plant communities typically have greater plant species richness and structural diversity and have co-evolved with local wildlife, and are therefore, better able to support broader wildlife requirements, *e.g.*, feeding, cover, migration, hibernation, and reproduction, than non-native or monoculture communities. For example, northern Harriers, which have nested within the study area during eight of the past ten years (Hallock and Jones 2010), require cattails or other dense vegetation for concealing their platform nests as well as nearby foraging areas that support populations of meadow voles, mice, and other rodents (Smith et. al. 2011). Currently, the upland prairies adjacent to the two most recently active Northern Harrier nesting sites are dominated by non-native vegetation and appear to support low concentrations mice and voles. Restoration of these areas to native prairie should improve both Northern Harrier foraging opportunities and nesting success.

3.11 1WILDLIFE SURVEY RESULTS AND DISCUSSION

A variety of wildlife surveys were conducted in 2013 for the purpose of establishing a comprehensive baseline of species currently living within the study area (see Figures 10 and 11 for survey locations and results).⁵ Survey techniques included Terrestrial Visual Encounter Surveys (TVES); nocturnal and diurnal amphibian surveys using call and visual identification; scent stations with infrared cameras to detect nocturnal carnivores and other species; small mammal trapping; and pedestrian surveys of the parcels to specifically look for wildlife and signs which may not have been detected using other survey techniques. Breeding and migratory bird surveys were also conducted. Appendices B and C describe details of the wildlife and bird survey methods. Inventories of insects and fishery resources were not included in the current assessment.

4.1 General Wildlife Surveys -TVES

Six TVES surveys were conducted at the Reservoir, two surveys at each of the three survey grids. In consultation with city staff, the TVES grids were located to intersect multiple vegetation types in areas large enough to accommodate their size (refer to Appendix B for additional description of methods). Species identification was based on habitat type per Armstrong et al. 2011). Since avian point-count surveys and distance sampling are being conducted separately as discussed in Section 4.5, bird species were not recorded within each TVES grid, unless considered rare or sensitive. The TVES surveys did not result in the identification of large mammals or rare or hard-to-detect wildlife species. According to the Species Range Mapping for select mammals by Colorado Parks and Wildlife Department (CPW), most or all of the property is within the overall ranges of mule deer, white-tailed deer, mountain lion, and potential Preble's Meadow Jumping Mouse habitat. The northwestern corner of the property also has black bear habitat, and the western portion of the property also provides winter range for mule deer (Refer to Figure B1 in Appendix B).

Species that were observed or detected include: Black-Tailed Prairie Dogs, Muskrat, Coyote, Woodhouse's Toad, Western Rattlesnake, and Eastern Cottontail Rabbit (please note that the three species of cottontails that occur within the Front Range are very difficult to distinguish in the field). Most of these species were found in all of the grids (Photograph 11). The Muskrat was only documented in the eastern TVES grid (No.3). Cattail stands are very dense within the northwest grid (No. 2) and portions of the western grid (No. 1), and no evidence (tracks, scat, or houses) of Muskrat use was seen within these areas. The lack of detection could have been either that Muskrats are not present at these locations or the vegetation was too dense to clearly detect their presence. The Western Rattlesnake was only detected in the



Photograph 11. Area covered with field bindweed.

Photograph courtesy of Jerry Powell.

western grid No. 1, however, though not detected during the survey; it is also known to occur in the vicinity of the other grids Nos. 2 and 3 based on personal observation and Park staff reports. The northwest TVES survey grid (No. 2) did result in the confirmation of nesting American Bitterns, which had been previously identified during avian point count surveys. One adult flushed and landed nearby, the area was not searched to locate the nest so that disturbance could be kept minimal.

TVES grids Nos. 1 and 3 were located within areas containing large numbers of Black-tailed Prairie Dogs, whose tracks, diggings, and scat obscured the detection of physical evidence of most other species presence. Black-tailed Prairie Dogs also

⁵ Note, informal wildlife observations have been collected for decades, and the bird surveys have been ongoing since 2004.

were present at grid No. 2, but were not as prevalent. The TVES survey grids also were in areas that were dominated by large mono-culture stands of smooth brome, field bindweed, and cattails. The TVES grid locations, with the presence of prairie dogs and low plant diversity dominated by non-native plant species, is representative of much of the habitat found within the zones surveyed. Because of the low plant diversity there is very little habitat available for most habitat generalist species (e.g. Deer Mouse, House Mouse, etc.) and limited habitat for species restricted to a narrow habitat niche. Additionally, in a study conducted in Utah, field bindweed (dominant at grids Nos. 1 and 3) was reported to be of low nutrient value and palatability to small mammals (Dittberner and Olson 1983).

4.2 Targeted Wildlife Surveys: Carnivore Camera Scent Stations

An infrared camera was used for detection at four scent stations for a total of 38 camera-nights. A total of seven wildlife species were detected: Coyote, Raccoon, Mink, Eastern Cottontail Rabbit, Black-tailed Prairie Dog, Western Meadowlark, and Snapping Turtle. Table 4 provides the camera station, species detected at the station, camera-nights per station, and total number of photographs that contained wildlife (many photographs were of grasses moving, dogs, etc.).

Table 4 Carnivore Camera Scent Station Results

Camera Station	Number of Camera-Nights	Species Detected	No. of Wildlife Photographs	Comments
No. 1 (West of Coot Lake)	7	Coyote & Eastern Cottontail Rabbit	24 (22 Coyote, 2 Rabbit)	Only location where dogs and people were photographed.
No. 2 (Northwest)	9	Coyote, Raccoon, Eastern Cottontail Rabbit	17 (6 Coyote, 9 Raccoon, 2 Rabbit)	Reservoir level raised; camera station in water when moved.
No. 3 (West)	8	Coyote, Raccoon, Eastern Cottontail Rabbit, Black-tailed Prairie Dog, and Western Meadowlark	76 (42 Coyote, 6 Raccoon, 12 Rabbit, 14 Black-tailed Prairie Dog, 2 Western Meadowlark)	No human activity near the camera station.
No. 4 (Coot Lake Wetlands)	14	Snapping Turtle, Raccoon, Mink, Unknown	50 (29 Raccoon, 11 Snapping Turtle, 6 Mink, 2 Unknown)	No human or dog sign noted within restricted access area near camera station.

The Coyote was the most commonly detected species, and Raccoons and Minks were the only other predators detected via camera scent stations (Table 4, Photograph 12). Scat of Ermine (Short-tailed Weasel) – another predator – was detected on the west side of the project area while checking small mammal traps. No other mammalian predators were detected. Camera scent stations do not allow for the determination of whether the photo is of an individual photographed numerous times or several individuals photographed a single time is not possible except in species with definitive markings (e.g. spots, stripes, etc.) that can be used to differentiate individuals.

The lack of Red Fox detections was expected and could be explained by the presence of Coyotes. Interference competition between Coyotes and Foxes are known to result



Photograph 12. Mink near camera scent station in Coot Lake Wetlands.

in direct mortality or exclusion of foxes (Gehrt and Clark 2003). Additionally, Coyotes are known to be major predators on many Fox species (White et al. 1994, White et al. 2000, Sovada et al. 1998). Studies do indicate that Coyotes can and do exclude or displace foxes, and there is an inverse relationship between abundance of Coyotes and Foxes (Blankenship 2013). Coyotes are not known to suppress raccoon populations (Gehrt and Clark 2003, Gehrt and Prang 2006).

4.3 Targeted Wildlife Surveys: Amphibians and Reptiles

Suitable amphibian breeding habitat was identified using criteria that included presence of a non-flowing body of water, such as marshy areas around the Reservoir, and areas in ditches or drainages with slow-moving open water (Photograph 13). Suitable amphibian habitat areas were surveyed to confirm occupancy and were mapped in GIS based on field Universal Transverse Mercator (UTM) coordinates collected via a hand-held Global Positioning System (GPS) unit.

Three species of amphibians --Woodhouse's Toad (native), Western Chorus Frog (native) and Bullfrog (non-native)-- were documented within the study area by both visual and aural detection. Both immature and adult Woodhouse's Toad and Western Chorus Frog were found throughout the survey area in areas containing suitable breeding habitat and adult Woodhouse's toads were found in dry upland areas throughout the study area (Photograph 14). The Woodhouse's toad is easily the state's most commonly encountered amphibian (Hammerson 1999), and the creation of the Reservoir likely resulted in an increase in breeding sites that were not present prior to the construction of the Reservoir. The growth of trees, sedges and rushes predominantly along the western and northwestern edge of the Reservoir has created ideal Western Chorus Frog breeding habitat. The Bullfrog, an aggressive non-native species, was found at three main locations (throughout the Coot Lake wetlands and two locations along the Dry Creek drainage). The population levels are unknown, but based on the number of calls heard at these locations the number of breeding adults may not be high yet, but is large enough to support population expansion short of focused, chemical control efforts. Successful breeding in the form of tadpoles and toadlets was confirmed only for the Woodhouse's Toad; only seasonal mating calls were heard for the other two species.



Photograph 13. Suitable amphibian breeding habitat.
Photograph courtesy of Jerry Howell.



Photograph 14. Recently metamorphosed Woodhouses' toadlet.
Photograph courtesy of Jerry Powell.

It is important to note that the amount and the quality of suitable breeding habitat can and will vary from year-to-year based on Reservoir water levels. In addition to mapped potential breeding habitat, all areas in which breeding was confirmed (either through visual detection of adults or young or the calling of males) were mapped in GIS. No evidence of use (via visual

detection or mating calls) was found for areas in which the cattails were thick, suggesting that suitable breeding habitat is not present within these locations. Thick cattails stands are not recognized as breeding habitat for any of these species (Hammerson 1999).

Five species of reptiles were detected within the study area. These species are the Snapping Turtle, Spiny Softshell Turtle, Racer, Western Terrestrial Garter Snake, and Western Rattlesnake. Of these species, the Western Rattlesnake was the most commonly detected species (four individuals), the Western Terrestrial Garter Snake second (two individuals), and only one detection of the Snapping Turtle, Spiny Softshell Turtle, and the Racer. All detections of the Western Rattlesnake were on the west and northwest side of the study area within the Prairie Dog colony or on the county road after dark between colonies. This is in keeping with research on herpetofauna diversity on and off-colonies where Shipley and Reading (2006) reported a greater occurrence of Western Rattlesnakes within colonies. One of the Western Terrestrial Garter Snake detections occurred where Woodhouse's tadpoles and toadlets were present and the snake appeared to be hunting the toadlets. Garter snakes are known to prey on Woodhouse's toadlets (Hammerson 1999). Though not detected within the study area, Bullsnares were often seen on county roads north of the project area and they are known to occur within the project area. The lack of detection could be attributed to their fossorial behavior (90% of their time spent underground— Hammerson 1999).

4.4 Targeted Wildlife Surveys: Small Mammal Trapping

The 600 trap-night survey resulted in a total of sixteen captures (eleven adults and four juveniles) of one species-- the Deer Mouse. The overall capture rate was 2.66 percent, which is very low for grassland and riparian habitats within the Front Range. In a study conducted at Cherry Creek Reservoir south of Denver in 2008 (Bakeman 2008) capture rates were 3.75 percent, much lower than the 10.9 percent capture rate reported by Meaney et al. (2002) in a Boulder County study along South Boulder Creek. Two transects, the westernmost of the pair on the west side of the Reservoir and the transect near Dry Creek, had more than one capture (Figure 11). Eleven captures (68 percent) occurred in areas with taller vegetation; the remaining 32 percent were in either field bindweed or a mixture of short weeds. Five Four hundred of the trap nights occurred with the traps being available at one location for one night.

Two hundred trap nights occurred with the trap at one location (50 traps out at two locations for two nights). In those traps that had consecutive trap nights at one location, captures were greater. However, when traps are left in one location for more than one night small mammals can and do develop an affinity for the traps and will return to that location, resulting in repeated captures of one individual. To fully develop a population estimate, a mark capture-recapture study would be necessary. Trap availability was high; of the 584 available trap nights (sixteen not available because of captures) two percent (12 traps) were recorded as 'closed/empty'. These traps were often found away from the original trap location with the batting removed, likely the result of raccoons tampering with the traps.

Other small mammal species historically documented at the Reservoir that were not observed in the 2013 survey season include the Shrew (species not defined), 13-Lined Ground Squirrel and Western Harvest Mouse. (Master Plan, 1983; Boulder Audubon Society, 1985; Park Ranger memorandum, 1985; ERO 2013). Though not detected during the 2013 surveys, habitat suitable for use by these species is available at the Reservoir. Species diversity is an index of community diversity that takes into account both species richness and the relative abundance of species. Richness is the number of species found in a community. The Simpson's index of diversity takes into account both the total number of species and how common or rare each species is. Thus, for a given evenness, diversity increases with species richness; similarly, for a given species richness, diversity will increase with evenness. This index is abstract, but can be used as a benchmark for future surveys. Evenness is a function of the relative abundance of the species that occur in a community. Simpson's index of evenness has a maximum value of one (even composition of each species), and lower values have a more disparate species composition with some species being more common and others being rare. Because of the low capture rate (sixteen total captures) and only capturing one species, both the Simpson's index of diversity and Simpson's index of 'equality' or 'evenness' have values of zero. Future surveys will likely have greater total captures of a greater number of species, increasing the richness and diversity of the small mammal population.

The low trapping rate and lack of general small mammal sign detected throughout the study area provide the following interesting results:

- The overall capture rate of 2.66 percent suggests that there are very low numbers of small mammals in the areas surveyed.
- The Deer Mouse, a habitat generalist typically found in high numbers, was the only species trapped and in low numbers.
- No mounds showing the presence of the Northern Pocket Gopher, the species with the greatest distribution within Colorado (Armstrong et al. 2011), were noted within the study area;

The following factors, singularly or in combination, could be responsible for the current low small mammal species richness and diversity:

- Drought and other environmental conditions can suppress small mammal populations. In 2012 the entirety of Colorado, for the first time in recorded history, was under severe drought conditions. Record high temperatures were recorded early in the growing season and the continued heat throughout the summer led to a reduction in biomass. Though the drought was less severe during the 2013 survey season, the effects (reduced seed production, a decrease in suitable habitat, etc.) of the 2012 drought likely influenced the 2013 survey results.
- Recreation and dogs could be impacting the small mammal community near Coot Lake and the east side of the Reservoir. Studies (Johnson 2000; Meaney et al. 2002; Lenth et al. 2006) have shown that small mammal species richness and diversity are influenced by recreation (including the physical impacts of trails) and dogs. Dogs were observed in most areas (except within the wetland enclosure at Coot Lake) near Coot Lake and on the east side of the Reservoir – often with no owner seen within the immediate area of the dog. Between the physical direct loss of habitat (trails), the fragmentation of habitat associated with trails, and the presence of a canines small mammal populations could be impacted where recreation does occur.
- Populations of small mammals fluctuate more or less regularly (Boonstra et al. 1998). Voles, a group of small mammals common throughout the Front Range, have fluctuations on an average of every three-five years (Boonstra et al. 1998). However, short-term studies suggest these ‘cycles’ to be measurable (Krebs, 1996) while longer-term studies (Boonstra et al. 1998) suggest these cycles to be less predictable. Schramm et al. (1990) reported high numbers of voles within their study area prior to a drought, no voles during the drought, and rare in the post-drought period. The zero capture of voles during the 2013 trapping period could be a relic of the preceding year’s drought. Additionally, the low vole population potentially could be a factor in the reported (S. Jones personal comm.) decrease in nesting and wintering Northern Harriers at Boulder Reservoir;
- Cover height and amount can be important in small mammal population regulation. Oftedahl (1976) reported overgrazed areas with short vegetation and bare ground favored the Deer Mouse and areas that were not overgrazed had a greater occurrence of voles (*Microtus* spp. – Oftedahl 1976).
- Prairie Dogs were present in all but one transect (west of Coot Lake), but the extent to which they may have had an effect on the survey results is unknown. There are varying reports of the effects of Prairie Dogs on faunal diversity. Prairie Dogs are an important keystone species, and their colonies are sometimes associated with a greater faunal diversity than adjacent lands. Recent research in New Mexico suggests effects “may vary by location, grassland type, or season. Although BTPDs negatively impacted a suite of grassland bird species, biodiversity is maximized in this landscape by maintaining a mixture of colonized and uncolonized habitats.” (Coguen, C. 2012; Agnew et al. 1986). City of Boulder personnel confirm they have observed higher numbers of small mammals in some Prairie Dog colonies in the city (Val Matheson, City Wildlife Conservation Coordinator, pers. comm.). However, few studies have compared on- and off-colony species *richness and diversity*; thus, it is difficult to determine how many species depend on prairie dog colonies (Stapp 1998, Kotliar et al. 1999). Recently, Cully et al. (2010) reported that small mammal species richness and evenness are less variable within colonies, and Pruett et al. (2010) reported species diversity and evenness to be greater outside of colonies. Decreases in species richness and evenness within colonies could result in part from changes in plant species composition (often towards a non-native invasive community) and a reduction of plant cover by Black-tailed Prairie Dogs (Baker et al. 2013). Observations are likely site-dependent and thus difficult to generalize; therefore, further study may be warranted at the Reservoir.

4.5 Bird Surveys

A breeding and migratory bird study was conducted at the Boulder Reservoir and Coot Lake to generate a comprehensive list of potential breeding birds and migratory birds within the study area; document and map nesting and concentration areas for raptors, waterfowl, waders, shorebirds, and species of special concern; and develop management recommendations for preserving and enhancing breeding and migratory bird habitat. Refer to Appendix C for detailed description of methods.

Between April 10 to July 31, 2013, 114 bird species were observed within the study area, including 82 potential nesting species (birds seen or heard within suitable nesting habitat during their documented breeding season; Kingery 1998). This number of potential nesting species is comparable to numbers detected within protected lands surrounding other large reservoirs in eastern Colorado during recent studies using the same methodology (Table 5).

Table 5. Potential nesting species documented in four reservoir parks in eastern Colorado.

Park	Observed	Potential Nesting	CNHP Tracked	Non-Native ²
Boulder Reservoir	55	82	6	5
John Martin Reservoir State Park ³	27	91	6	8
Lake Pueblo State Park ⁴	44	95	7	6
North Sterling Reservoir State Park ⁵	24	69	5	5

¹ Colorado Natural Heritage Program. 2012. Tracked bird species.

² Not documented nesting in Colorado prior to 1900 (Bailey 1902, Henderson 1908, Kingery 1998).

³ Jones 2013. ⁴ Jones 2011. ⁵ Jones 2008.

Potential nesting species observed during 2013 included nine geese and ducks; three herons and ibis; seven birds of prey; two rails; five shorebirds, four doves and owls, two woodpeckers, four flycatchers, three corvids, four swallows, three wrens and gnatcatchers, three thrushes, two warblers, five sparrows, eight icterids, and three finches (See complete species list in Appendix C, Table 2). Four additional potential nesting species – Burrowing Owl, Common Nighthawk, Red-headed Woodpecker, and Lark Bunting – were observed during surveys conducted by Boulder Parks and Recreation volunteers monitoring birds of special concern from 2009-12 (Appendix C, Table 3). Of the 2009-2013 total of 87 potential nesting species, 29 were confirmed nesting within the study area in 2013, and an additional 28 probably nested based on exhibited nesting behaviors (Appendix C, Tables 2 and 3).

4.5.1 Historic Bird Observations

Historic observations of potential nesting species at or within 1km of Boulder Reservoir are available from Boulder County Audubon Society from 1980-2013.⁶ Because there are no controls for observer effort in this inventory, these observations are more suggestive of presence, rather than absence, of individual species. In other words, the absence of reports of a given species during a given five-year interval should not be interpreted as evidence that the species was not present. Moreover, since Boulder Parks and Recreation initiated their species of special concern monitoring program in wetlands surrounding the Reservoir in 2004, numbers of reported observations to the wildlife inventory have increased significantly. Nevertheless, Boulder County Wildlife Inventory records do shed light on some changes in nesting bird populations at Boulder Reservoir. A total of 10 species which were not reported between 1980-1999 were reported during 2000-13: Wood Duck, Blue Jay, Orchard Oriole Northern Bobwhite, Red-headed Woodpecker, Eurasian Collared-Dove, Blue-gray Gnatcatcher, Gray Catbird, Cedar Waxwing, and Dickcissel.

- Wood Ducks, Blue Jays, and Orchard Orioles are native to eastern North America, and their numbers have increased throughout eastern Boulder County since 1980 as native cottonwoods and non-native willows have

⁶ Surveys were within Boulder County Wildlife Inventory area 22, which encompasses most of the study area, including all of Boulder Reservoir and lands east of North 51st Street, south of Monarch Road, west of North 63rd Street, and north of the Boulder-Longmont Diagonal Highway.

proliferated along prairie streams (Boulder County Audubon Society 1979-2013, National Audubon Society 2013).

- Northern Bobwhites and Red-headed Woodpeckers are rare and declining nesting species in Boulder County (Hallock and Jones 2010), and each was reported only once within the study area during 2000-13.
- Eurasian Collared-Doves are native to the Indian subcontinent and were first reported in North America during the 1980s, when caged birds imported to the Bahamas somehow made their way to Florida (Fuller 2004). They have since radiated out throughout much of North America, including Alaska (Fuller 2004).
- Blue-grey Gnatcatchers and Gray Catbirds are native shrub-nesters whose numbers may have increased in Boulder County in recent decades as cattle were removed from plains and foothills shrubland areas, enabling shrub-nesting habitat to expand (Boulder County Audubon Society 1979-2013; Chase and Cruz 2013).
- Dickcissels nest in tallgrass prairies and disturbed agricultural fields throughout the central and eastern Great Plains (Kingery 1998b). Singing males occasionally irrupt into Boulder County during late spring and early summer of years when drought conditions impact large areas of the Great Plains (Kingery 1998b, Boulder County Audubon Society 1979-2013). Dickcissels have never been documented nesting successfully in Boulder County (Hallock and Jones 2010).

Several potential nesting species, including Blue-winged Teal, Cinnamon Teal, Northern Harrier, and Burrowing Owl, were reported more frequently within the study area during 1980-99 than during 2000-13 (Boulder County Audubon Society 1979-2013). See the Species of Special Concern Section 4.6 for a discussion of some of these species. Lewis's Woodpecker was reported once within the study area, in October 1984. Mature cottonwoods along the shoreline of Coot Lake could constitute potential nesting habitat (Kuenning 1998). Rock Wrens were reported within the study area during the 1980s and 1990s but haven't been reported since 2000. They typically choose broken cliffs for nesting, but they can also nest on talus slopes and dam abutments (Jones 1998), so periodic nesting at the Reservoir is conceivable.

4.5.2 Nesting Bird Population Densities

Table 6 shows estimated breeding season (June-July) population densities of the 13 most abundant species observed during 2013, derived from distance sampling and analysis in the program Distance--a Windows-based computer package developed in Scotland to analyze distance-sampling surveys of wildlife populations (Thomas et. al. 2010)⁷. The analysis suggests that Red-winged Blackbird is by far the most abundant nesting songbird species within the study area, followed in estimated density by Cliff Swallow, American Goldfinch, Common Grackle, American Robin, Brown-headed Cowbird, Common Yellowthroat, Yellow Warbler, Mourning Dove, and Western Meadowlark. Of these 10 species, two nest predominantly in marshes (Common Yellowthroat and Red-winged Blackbird), one nests predominantly in riparian woodlands (Yellow Warbler), one nests predominantly in a mixed grasslands (Western Meadowlark), and the remaining six are habitat generalists that nest in a wide variety of ecosystems, including urban areas (Kingery 1998).

These estimated densities reflect the proximity of Boulder Reservoir to several urban areas, the presence within the study area of buildings, bridges, and other structures where urban-adapted generalists often nest, and the coverage of much of the study area by cattail marshes and mixed grasslands. While these data may be of limited value when analyzing habitat quality and

⁷ The Distance program (Thomas 2010) employs a half-normal cosine model to examine numbers of a given species observed at various distances and then assigns a detectability index to each species. The index is applied to estimate the absolute density of a given species within the survey area (Thomas et. al. 2010). The software is better at estimating populations of smaller songbirds that tend to distribute evenly within a given habitat type than of ducks and other larger birds that may aggregate into summer flocks. Since most of the Canada Geese and Mallards counted from point-count stations in June and July had already aggregated into flocks and most sightings were at a distance > 100 m from the observer, estimates of absolute density of these species within the study area are unreliable (see Density Ranges and Coefficients of Variation in Table 6). In addition, Distance can generally make reliable density estimates when provided with at least 60 observations of a given species. Of the songbirds observed from point-count stations, only Cliff Swallow, Red-winged Blackbird, and Western Meadowlark met this criterion (see Number/Point/Survey column).

management, they do provide a baseline for comparing Boulder Reservoir bird populations over time and with bird populations within other public parks throughout Colorado. For example, a future decrease in the density of Common Grackles and Brown-headed Cowbirds might indicate a reduction in the amount of native habitat fragmentation within the study area.

Table 6. Estimated density/ha of most abundant species.

Species	Number/point/ survey	Estimated density/ha	Density Range at 0.95 confidence interval	Coefficient of Variation ¹
Red-winged Blackbird	5.12	8.048	6.678 - 9.698	.095
Cliff Swallow	4.30	3.405	2.226 - 5.207	.218
American Goldfinch	0.79	1.811	1.268 - 2.586	.179
Canada Goose	2.61	1.771	.781 - 4.016	.428
Common Grackle	0.79	1.725	.880 - 3.382	.344
American Robin	0.49	.792	.518 - 1.209	.210
Brown-headed Cowbird	0.59	.690	.515 - .923	.144
Mallard	1.19	.489	.182 - 1.312	.531
Common Yellowthroat	0.95	.435	.322 - .588	.151
Yellow Warbler	0.77	.402	.311 - .519	.129
Mourning Dove	0.90	.371	.237 - .579	.224
Killdeer	0.52	.348	.159 - .763	.402
Western Meadowlark	1.41	.180	.131 - .246	.160

1. The coefficient of variation shows the extent of variability in relation to the mean of the population. Values above 0.2 tend to indicate that density data are not reliable

4.5.3 Nesting Bird Concentration Areas

The highest numbers of potentially breeding birds were observed in wetlands and cottonwood groves in the Dry Creek drainage and shoreline area at the northwest corner of the Reservoir, the Little Dry Creek south inlet at the southwest corner of the Reservoir, and the wetlands to the west of Coot Lake (Appendix C [Tables 6 and 7, Appendix IV]). During May and June the Dry Creek inlet supported at least 21 species of foraging waterfowl, waders, and shorebirds, including Blue-winged Teal, Cinnamon Teal, Northern Shoveler, Green-winged Teal, Great Egret, White-faced Ibis, American Avocet, and Semipalmated Plover (Appendix C, Table 11). However, of the waterfowl, herons, and shorebirds observed within the inlet, only Canada Goose, Mallard, Killdeer, Spotted Sandpiper, and Wilson's Snipe appear to have nested successfully.

Shallows and wetlands on the west side of Coot Lake supported concentrations of migratory waterfowl and grebes, including Canada Goose, Mallard, Redhead, Lesser Scaup, Greater Scaup, Ring-necked Duck, Common Merganser, Red-breasted Merganser, Eared Grebe, and Western Grebe. However, of these species only Canada Goose and Mallard demonstrated behaviors (such as territorial defense or fledged young) consistent with actually nesting in these wetlands.

Crowded cattail marshes in the Little Dry Creek drainage appear to support lower numbers of nesting species and individuals than do the more vegetatively complex marshes in the Dry Creek drainage and west of Coot Lake. The Dream Cove area, just northeast of the Boulder Reservoir entrance gate, supported relatively high numbers of individuals during both migratory and breeding bird surveys; however, nearly two-thirds of these birds were urban-adaptive generalists such as Canada Goose, Mallard, American Robin, and European Starling. These urban generalists species are birds that can tolerate a wide range of habitat and environmental conditions including man-made disturbances (e.g., light, noise, vegetation characteristics), and therefore, they are not generally considered indicators of high habitat quality.

Areas of steeper shoreline along the west and north shores of the Reservoir supported relatively low numbers of migratory and nesting birds. In these areas, the "bathtub ring effect"--whereby large areas of bare shore are exposed in early spring and create an inhospitable barrier between the Reservoir surface and any sheltering shoreline vegetation--probably precludes successful nesting by most ducks and shorebirds.

Though surveyors observed a few Horned Larks, Vesper Sparrows, Lark Sparrows, Grasshopper Sparrows, and several dozen Western Meadowlarks around the Reservoir, breeding densities of these grassland-nesting species appear to be low compared to densities in more natural prairies east of Boulder County (Kingery 1998). Grasslands surrounding Boulder Reservoir are dominated by non-native grasses and may provide poor nesting structure and foraging opportunities for most grassland-nesting birds.

4.5.4 Migratory Bird Concentration Areas

Sampling locations along Dry Creek and its inlet (Nos. 7 and 11) supported the highest mean numbers of migratory bird species and individuals, as well as the most total species (Appendix C, Table 9). These plots also supported relatively low percentages of more common (or urban-adapted) and non-native species. The Dry Creek marsh and Little Dry Creek north and south inlets (Plot nos 1-5) supported substantially lower mean numbers of migratory bird species and individuals, along with substantially fewer total species and higher percentages of urban-adapted and non-native species. During followup focused surveys in these areas, 21 waterfowl, heron, and shorebird species were observed within the Dry Creek inlet compared to only eight within the Little Dry Creek north inlet and only seven within the Little Dry Creek south inlet. Birds observed within the Dry Creek inlet included two Colorado Natural Heritage Program tracked species (American White Pelican and White-faced Ibis) and a Boulder County Nature Association species of special concern (Great Egret).

Characteristics which may attract more waterfowl, herons, and shorebirds to the Dry Creek inlet than to the Little Dry Creek inlets include a gradually sloping shoreline, presence of extensive mud flats and a significant area of shallow water offshore, and presence of native shrubs and sedge/rush wetlands close to the shoreline. Summer aerial photos of this inlet from Google Earth show a plume of brownish silt emanating from the mouth of Dry Creek and spreading out across most of the inlet, whereas no such silt plume appears on comparable aerial photos of the Little Dry Creek north and south inlets. In 1987, the City of Boulder acting in consultation with the Boulder County Nature Association, installed check dams across formerly channelized Little Dry Creek upstream from North 51st Street to create a new cattail marsh. This marsh, another marsh along Dry Creek west of North 53rd Street, and the wetlands west of Coot Lake were created to mitigate for loss of wetlands resulting from hardening of the Boulder Reservoir spillway and a consequent raising of the Reservoir water level by up to four feet. It is possible that the diversion of water flows from formally channelized Little Dry Creek into the newly created marshes eliminated much of the flow of silt from this creek into the Reservoir inlets, indirectly leading to a steepening of shoreline areas or deepening of near-shoreline waters.

In addition, the presence of two Osprey nesting platforms on poles within 50 m of the shorelines of the Little Dry Creek inlets may discourage ducks and shorebirds from foraging there. Though Ospreys prey primarily on fish, they are opportunistic feeders and may harass foraging ducks and shorebirds (Poole, Bierregard, and Martel 2003).

During April and May migratory bird surveys, up to 75 geese, ducks, grebes, waders, and gulls were observed floating on Coot Lake or wading near shore. Species observed included Canada Goose, Wood Duck, Gadwall, American Wigeon, Mallard, Redhead, Lesser Scaup, Greater Scaup, Common Merganser, Eared Grebe, Western Grebe, Clark's Grebe, Great Blue Heron, American Coot, and Ring-billed Gull. Most of these birds had departed by the first week of June, and of them only Canada Goose and Mallard appeared to nest within the Coot Lake wetlands.

4.6 Bird and Mammal Species of Special Concern

4.6.1 Bird Species of Concern

Wetlands on the west side of Boulder Reservoir and west of Coot Lake have been designated as Critical Wildlife Habitat in the Boulder County Comprehensive Plan due to the presence of nesting American Bitterns (Boulder County isolated and restricted), Ospreys (Boulder County isolated and restricted), and Northern Harriers (Boulder County rare and declining; Hallock and Jones 2010).

Table 7 lists these and other bird species of special concern observed during the 2013 survey, followed by descriptions of each bird.

Table 7. Colorado Natural Heritage Program tracked birds and Boulder County Nature Association/Boulder County Parks and Open Space birds of special concern observed during 2013 surveys.

Species	CNHP ¹	BCNA/BCPOS ²	State	Federal: USFS/BLM	Boulder Reservoir Status
American Bittern	---	Isolated and Restricted	---	USFS Sensitive	Four to five breeding territories annually in wetlands near Reservoir ³
American White Pelican	G3;S1B	---	---	BLM	Summer resident; no documented nesting in Boulder County; no nesting habitat (i.e., predator-proof islands) within Boulder County
Bald Eagle	G5;S1B,S3N	Isolated and restricted	State concern	USFS Sensitive	Summer resident; nest failed in 2007.
Bobolink	G5;S3B	Isolated and restricted	---	---	No nesting habitat within study area.
Dickcissel	---	---	---	---	Unusual based on observations. Never been documented nesting in Boulder County; all recent sightings have been of singing males with no pairs observed.
Eared Grebe	---	Rare and Declining	---	---	Fairly common migrant; no nesting habitat at Boulder Reservoir; no documented nesting in Boulder County since at least 1980.
Forster's Tern	G5;S2B,S4N	---	---	---	Summer resident non-breeder
Grasshopper Sparrow	---	Isolated and restricted	---	USFS Sensitive	Singing males 13 May and 2 June; suitable nesting habitat exists
Great Egret	---	Isolated and Restricted	---	---	Summer visitor; nests at St. Vrain State Park
Loggerhead Shrike	---	Rare and declining; isolated	---	USFS Sensitive	Seen 25 April 2013; suitable nesting habitat may exist
Long-billed Curlew	G5;S2B	Extirpated nesting species	State concern	USFS Sensitive	Seen 22 April and 10 May 2013; marginal nesting habitat exists.
Northern Bobwhite	---	Rare and Declining	---	---	Rare; no documentation of nesting
Northern Harrier	---	Rare and declining; isolated	---	USFS Sensitive	Nests occasionally in wetlands surrounding Reservoir ⁴
Osprey		Isolated and restricted			Nests annually on west side of Reservoir.
White-faced Ibis	G5;S2B	---	---	BLM	Summer visitor; no documentation of nesting

¹ Colorado Natural Heritage Program. 2012. CNHP tracked bird species. www.cnhp.colostate.edu/download/list/birds.asp

Colorado Natural Heritage Program Global Ranking Codes: G3, vulnerable to extirpation or extinction; G4, widespread, abundant, and apparently secure; G5, demonstrably widespread, abundant, and secure; T, rank applies to subspecies or variety. State Ranking Codes: S1, state critically imperiled; S2, state imperiled; S3, state rare or uncommon; S4, state apparently secure; B, breeding populations; N, non-breeding populations.

²Hallock, D., and S.R. Jones. 2010. Boulder County avian species of special concern. Boulder County Nature Association, www.bcna.org. Also included in Boulder County Comprehensive Plan.

³ Roughly half of the recently documented American Bittern nesting territories in Boulder County are in wetlands surrounding Boulder Reservoir (Hallock and Jones 2010, Jones 2006-12).

⁴ These nest sites, located in cattail marshes west and northeast of the Reservoir, are the only documented successful Northern Harrier nesting sites in Boulder County since 1983 (Hallock and Jones 2010, Jones 2006-13).

Summary discussions of select species that qualified as potential nesting species within the study area of the tracked birds in Table 7 follow (in alphabetical order), and additional details are provided in Appendix C.

American Bittern. (Boulder County isolated and restricted, USFS sensitive). American Bitterns lay their eggs on platform nests constructed in dense emergent vegetation or, less frequently, in dense grasslands (Gibbs, Melvin, and Reid 2009). North American nesting success appears highest within large unfragmented marshes (Gibbs, Melvin, and Reid 2009). As a result of fragmentation and loss of wetlands, along with pesticide contamination and human disturbance of marshes, North American breeding populations have declined significantly since 1966 (Kingery 1998; Gibbs, Melvin, and Reid 2009). Sauer, Hines, and Fallon (2012) reported an annual rate of decline of nearly 1.8% from 1966- 2011 on North American Breeding Bird Survey routes.

During 2013, we identified three American Bittern nesting territories within the Dry Creek marsh area east and west of North 51st Street and a fourth American Bittern nesting territory in the Coot Lake wetlands (Appendix C, Figure 2). We detected no American Bitterns in the Little Dry Creek drainage, where calling bitterns were observed annually from 2004-09 and 2011-12 (Appendix C:Figure 3 and Table 11; Jones 2006-13). The total of seven American Bittern nesting territories documented within wetlands surrounding Boulder Reservoir from 2004-13 comprises at least half of all American Bittern nesting territories reported in Boulder County from 1980-2013 (Hallock and Jones 2010, Jones 2006-13).

All but one of the known sites (Six-Mile Reservoir) lie on public lands, but their vulnerability to urban-adapted predators and proximity to recreational trails may limit nesting success. Young bitterns are difficult to detect among the cattail foliage, and any attempt to count or band young would require disturbance of nesting areas. Therefore, it seems most prudent to continue to monitor sites from a non-intrusive distance, limit human encroachment within 200 m of any active nests, and strive to expand the areas of protected cattail marshes and surrounding wetlands. Strategies that increase the size of marshes and protect them from disturbance by humans and domestic dogs should benefit nesting bitterns. Although Boulder County populations appear to be stable (Hallock and Jones 2010), the species still appears limited to a dozen documented nesting sites in the county, and eight of these are in wetlands adjacent to Boulder Reservoir, privately-owned Six-Mile Reservoir, and Coot Lake. All of the known sites are in small (< 5 ha) cattail marshes near reservoirs or within floodplains, and most lie in areas that have been fragmented by mining, farming, roads, or trails.

Bald Eagle (Boulder County isolated and restricted, State concern, CNHP fully tracked, USFS sensitive)

Bald Eagles have been observed every winter at Boulder Reservoir since at least 1979 (Boulder County Audubon Society 1979-2013, Boulder County Nature Association 2012). In March 2007, a pair began constructing a nest on the Osprey nesting platform on the Axelson open space property 50 m west of North 53rd Street. This pair was displaced by a pair of nesting Ospreys by early April. Bald Eagles were first documented nesting in Boulder County in 2002, and

six pairs nested within the county in 2013 (Hallock and Jones 2010, Boulder Open Space and Mountain Parks 2013). Suitable nesting habitat (cottonwood groves within proximity to open water) exists within the study area.

Bobolink (Boulder County isolated populations; CNHP fully tracked) A singing Bobolink was observed on the fence separating Coot Lake from the open space property to the north on June 2, 2013 (Appendix C, Figure 8). In Colorado, bobolinks nest primarily in irrigated hayfields and damp, grassy meadows. Isolated stalks of shrubs or forbs within the meadows serve as perch sites for singing males. Dense grassy cover around ground nests helps to conceal the nests from predators and enables adults to enter and exit the nests without being seen (Katempfer 1998). Suitable nesting habitat (wet meadows) exists within the Dry Creek marsh, but no Bobolinks were seen or heard there, and Bobolinks have not been documented nesting within the study area.

Grasshopper Sparrow (Boulder County isolated populations) Grasshopper Sparrows were heard singing in mixed-grass prairies near the northeast corner of Coot Lake on May 13, 2013, and a pair was observed in the same location on June 2, 2013. Patches of suitable nesting habitat (bunch grasses interspersed with areas of bare ground) for Grasshopper Sparrows exist throughout the study area, so it's likely that they nest at least occasionally.

Loggerhead Shrike (Boulder County rare and declining, USFS sensitive) Loggerhead Shrikes nest in shortgrass prairies throughout eastern Colorado and were considered common during the late 19th and early 20th century (Carter 1998). Their nesting habitat has been reduced by agricultural operations and nesting success has been impacted by pesticide poisoning of insect prey and collisions with automobiles (Ehrlich et. al. 1992). In Boulder County, no nesting has been documented during the past three decades (Hallock and Jones 2010). A single Loggerhead Shrike was observed perched in a Russian-olive in the small ravine that bisects the north dam north prairie dog colony on April 24, 2013. No Loggerhead Shrikes were seen on any subsequent survey dates. Small patches of shortgrass prairie nesting habitat exist within the study area, and as native prairies are restored and rehabilitated, opportunities for Loggerhead Shrike nesting should increase.

Long-billed Curlew (Boulder County extirpated breeding populations, State concern, CNHP fully tracked, USFS sensitive) Long-billed Curlews nested in Boulder County during the late 19th century (Henderson 1908), before most native prairies in the county were destroyed or severely fragmented by agricultural operations and urban growth. However, a few individuals still pass through the county during spring migration. At least five Long-billed Curlews were observed within the study area in April and May 2013 (Appendix C, Figure 7). Long-billed Curlews typically nest in mixed-grass prairies close to shallow ponds or mud flats, where there is adequate cover for concealing their ground nests and barren ground where they can forage for invertebrates (Nelson 1998). They are considered an indicator of healthy native grasslands (Nelson 1998). Restoration of mixed-grass prairies surrounding Boulder Reservoir and Coot Lake to native grasses could create suitable nesting habitat for this species.

Northern Harrier (Boulder County rare and declining, USFS sensitive) In Boulder County Northern Harriers typically build their platform nests on the ground in cattail marshes. They were considered a "fairly common" local nesting species during the first decade of the 20th century (Henderson 1908), but their numbers appear to have dwindled since then (Alexander 1937, Boulder County Audubon Society 1979-2013, Hallock and Jones 2010). The only Northern Harrier nests documented in Boulder County since 1979 have been in the cattail marshes west of Boulder Reservoir and west of Coot Lake and in a small cattail marsh west of Lagerman Reservoir. Only the Boulder Reservoir and Coot Lake nests have fledged young (Hallock and Jones 2010).⁸ As such, this species should be a focal species for

⁸ Nesting Northern Harrier populations have declined throughout many regions of North America. Fragmentation of wetland breeding habitats by agriculture, along with poisoning of rodent prey populations by herbicides and pesticides have probably contributed to this decline (Smith et. al. 2011). Although created wetlands provide hunting opportunities, nesting habitat is less.

habitat restoration and management priorities e.g., by increasing protection of the western wetlands, improving the quality of the cattail marshes, and improving the diversity of the grasslands to better support small mammal (prey) populations.

The annual monitoring of nesting Northern Harriers within the study area began in 2004; and since that time, 2012 and 2013 were the first years when no evidence of attempted nesting was observed (Appendix C, Table 13).⁹ In 2013, a pair of foraging Northern Harriers was observed flying low over and occasionally descending into the Little Dry Creek and Dry Creek cattail marshes throughout April and early May. However, no evidence was found of nesting, and no Northern Harriers were observed within the study area during June or July. In 2014, bird monitoring found Northern Harriers were again nesting in the Little Dry Creek drainage.

It's likely that fragmentation of potential nesting habitat by roads, agriculture, and other human activities severely limits Northern Harrier nesting opportunities and nesting success in Boulder County. Nests situated in smaller, fragmented marshes may be more susceptible to predation by carnivores and raptors (Smith et. al. 2011). Coyotes were often observed nosing around Northern Harrier nesting areas west of the Reservoir, and Red-tailed Hawks were seen harassing nesting harriers (Jones 2006-13). We also suspect that low prey populations may have discouraged harriers from wintering in this area and may also have discouraged them from nesting. Additionally, encroachment by hikers and their dogs into the closed area surrounding the Dry Creek Northern Harrier nesting site was reported on several occasions by volunteers during the 2012 and 2013 nesting seasons (see Management section for details).

Based on recent observations, Northern Harrier appears to be the most endangered nesting bird species in Boulder County (see Hallock and Jones 2010) with only four successful nestings during the past 10 years and no nests during 2012- 2013. Therefore, every conceivable effort should be undertaken to protect and expand potential nesting areas. Colorado State Parks and Wildlife give no specific nest buffer recommendation for this species, but they recommend nest buffers of 400 m (no surface occupancy beyond what historically occurred in the area) for similar-sized Swainson's Hawks, and 800 m buffers for Peregrine Falcon, Prairie Falcon, and Goshawk (Colorado Division of Wildlife 2008). In instances when pairs may choose to nest within 400 m of existing trails or other recreational facilities, seasonal closures of those facilities will contribute to nesting success. Raptors may be more inclined to abandon nesting sites during the nest-building and early incubation periods than during the chick-rearing period. In other words, their fidelity to the nest often increases as the chances of successfully fledging young increases (Colorado Division of Wildlife 2008; Craighead and Craighead 1965). The Northern Harrier nesting chronology, below, based on observations at Boulder Reservoir from 2006-13, can inform decisions about seasonal closures:

Nest building: 12 April-14 June

Incubation: 12 May-26 July

Feeding young on or near the nest: 25 May-7 July

Fledged (independently flying) young: 10 July- 15 August

⁹ Successful nesting occurred in the Coot Lake wetlands in 2004 (4 young fledged), in the Little Dry Creek wetlands in 2004 (4 young fledged) and 2009 (4 young fledged), and in the Dry Creek wetlands in 2010 (3 young fledged). These are the only successful Northern Harrier nests that have been documented in Boulder County since 1987 (Hallock and Jones 2010, Jones 2006-13), suggesting that nesting populations of this species are critically imperiled in Boulder County. Unsuccessful nesting occurred in the Little Dry Creek wetlands in 2005 and 2007-8 and in the Dry Creek wetlands in 2006, 2008, and 2011. The total of only 15 young fledged from all these nesting attempts since 2004 is probably not enough to sustain a viable nesting population (Johnsgard 1990).

Northern Harriers are commonly observed in Boulder County during the winter (Boulder County Audubon Society 2011), and during winters of 2004-13 as many as 15 harriers were observed roosting communally on the ground in cattail marshes west of the reservoir (Ted Floyd, pers. comm.). During the winter of 2012, only 1-2 roosting harriers were reported in these marshes (Boulder County Audubon Society 1979-2013).

Osprey (Boulder County isolated and restricted) Ospreys were first observed nesting near Boulder Reservoir in 1998 (Jones 2006-13). Though they nested historically in the mountains of the Colorado Front Range, there was no documentation of nesting on the plains of Boulder County before the mid-1990s (Hallock and Jones 2010). They have nested at four locations within 2 km of Boulder Reservoir (Appendix C, Figure 4.) From 2004-10, the three nesting sites closest to the Reservoir (the two platforms at Little Dry Creek and the platform near Dry Creek) fledged a total of 28 young. The Axelson/Dry Creek site was particularly productive, fledging 20 young from 2004-10. From 2011-13, these sites fledged only five young.

During 2013, all four active nests failed. The North Rim and Axelson nests apparently failed during incubation, the Little Dry Creek north site after we observed two chicks on the nest in early June, and the new site south of the Reservoir failed when the nest caught fire and was taken down by Excel Energy. The Little Dry Creek south platform was appropriated by a pair of Canada Geese during 2012-13. Reasons for nest failures at the previously productive Axelson site during 2011-13 are unknown, but the sudden drop-off in productivity suggests that one of the original pair may have died and its replacement is either less fertile or less skilled at defending or provisioning a nest.

Nest monitors noted one instance of a hiker illegally entering the Little Dry Creek wildlife closure area and flushing one of the Ospreys off the nest in May (see Management section for details). Monitors noted no instances of direct disturbance of the Dry Creek Osprey nest. However, while engaging in bird surveys, surveyors frequently saw photographers parking illegally at the turn in the road to photograph the nest.

Colorado State Parks and Wildlife recommends nest buffers (no human activity or occupation) of 400 m around active Osprey nests (Colorado Division of Wildlife 2008). This is not possible at Boulder Reservoir, since North 51st Street passes within 150 m of two nests and North 53rd Street (the northern continuation of North 51st) within 50 m of a nest. However, nesting Ospreys can habituate to human activities better than many other raptor species (Poole, Bierregard, and Martel 2003), so the current wildlife closure areas may be sufficient to protect nesting pairs. Ospreys typically arrive at the Reservoir in March and begin nest building in April. The following nesting chronology, based on observations at Boulder Reservoir from 2006-13, can inform decisions about seasonal closures:

Nest building: 20 March-30 July

Incubation: five April-11 June

Visible young on nest: 13 May-20 July

Fledged young: 26 July-12 August

White-faced Ibis (CNHP fully tracked, BLM tracked) White-faced Ibis nest in scattered locations of eastern, southern, and northwestern Colorado in emergent wetlands often containing bulrushes and cattails (Ryder 1998). Breeding numbers vary dramatically from year to year depending on water levels in favored marshes (Ryder 1998). In 2013, flocks of up to 75 White-faced Ibis were observed flying over the Little Dry Creek drainage and wading in the shallows of the Dry Creek inlet during April and May. Cattail marshes within the Dry Creek drainage could provide suitable nesting habitat. However, there are no historical nesting records for White-faced Ibis anywhere in Boulder County, and the closest recently-documented nesting site is at Lower Latham Reservoir, 50 km northeast of the study area (Hallock and Jones 2010, Ryder 1998).

Burrowing Owl (Boulder County isolated and restricted, State threatened, USFS sensitive)

Though not observed in the study area during the 2013 survey, the Burrowing Owl is a species of concern that has historically been present at the Reservoir. Burrowing Owls nested successfully in the prairie dog colony east of the north dam and south of Coot Lake in 1988, 1989, and 2004; on the Boulder Reservoir north shore in 1982-3; and on the Axelson property northwest of Boulder Reservoir in 1986, 2008, and 2012 (Appendix C: Figure 7; Table 16; Jones and Mahoney 2003, Jones 2006-13).

Low fledge rates of nests during the past 20 years (Jones and Mahoney 2003, Boulder County Nature Association unpublished data) suggest that high mortality of young owls, possibly caused by predation, has contributed to low burrowing owl numbers throughout the county. A total of 46 nesting attempts observed within Boulder County from 2008-12 produced only 113 visible young (Appendix C, Table 17). This nest productivity is significantly below that reported for other High Plains burrowing owl populations (Johnsgard 1999) and may not be sufficient to maintain viable nesting populations.

Burrowing Owls nesting in smaller prairie dog colonies appear more vulnerable to predation and have fewer potential nesting burrows to choose from (Desmond, Savidge, and Eskridge 2000; Lance, Smith, and Keinath 2004). In addition, larger numbers of Burrowing Owls nesting in larger prairie dog colonies may gain an advantage over predators through increased vigilance. American Badgers, Coyotes, Red Foxes, Red-tailed Hawks, and Great Horned Owls are considered significant predators of Burrowing Owls (Lance, Smith, and Keinath 2004). Automobiles also kill burrowing owls. Over a five-year period during the 1990s, 26 of 28 injured burrowing owls admitted to the Birds of Prey Rehabilitation Foundation in Broomfield, Colorado, had been struck by cars (Sigrid Ueblacker, pers. comm.).

Colorado State Parks and Wildlife recommends no human occupancy or activity within 150 feet of active Burrowing Owl nests (Colorado Division of Wildlife 2008). Burrowing Owls typically arrive in Boulder County in April and begin nesting in late April or early May (Kingery 1998). The nesting chronology below, based on monitoring of Burrowing Owl nests on Boulder County Parks and Open Space properties from 2009-13 (Jones 2011-13), can inform decisions about seasonal closures:

Pairs first seen on territory: 15 April-9 May

Suspected incubation/brooding of young: 25 April-28 June

First visible young: eight June-12 July

Young flying from natal burrow: four July-1 August

4.6.2 Mammal Species of Concern

Black-Tailed Prairie Dogs are an important part of the native prairie ecosystem where their burrows aerate soils, infiltrate water, and provide habitat for other species such as Burrowing owls. Prairie dogs are also prey for numerous predators including the endangered Black-footed Ferret and many other mammals and raptors. Despite their ecological significance, habitat loss from agriculture and urban development has reduced their once-vast territory to remnant, refugia parcels across the state. As a result, they are listed by the Colorado Division of Parks and Wildlife (CPW) as a species of Special Concern with a state rank of S3 (rare or uncommon) and a global imperilment rank of S4 (abundant and apparently secure, but with a long-term concern – CNHP 2013).

Within the City of Boulder, the city has been actively managing Prairie Dogs for decades. Boulder's Black-Tailed Prairie Dog Management Plan of 1996 set the early foundation for their protection and management. The city Open Space and Mountain Parks' Grassland Ecosystem Management Plan (2009) provides observations of the viability and opportunities for Black-tailed Prairie Dog conservation on open space properties (including those around the Reservoir). In addition to the OSMP Grassland Plan, the Black-Tailed Prairie Dog component of the city's 2006 Urban Wildlife Management Plan (UWMP) established the city's goals and management priorities on an area-by-area analysis. The UWMP identifies a Habitat Conservation Area (HCA) on the east side the Reservoir (in both the North and South Dam zones) as one of the city's larger long-term protection area (134 acres), excluding the areas within 100 feet of the base of the dams. (The Plan does not designate a management regime for the colonies on the west side of the Reservoir¹⁰.)

¹⁰ According to city Conservation staff, when the UWMP was written in 2006, the western areas were already being managed by the Parks and Recreation Department as prairie dog habitat with most of the area closed to the public. Because there were no plans to change that status or to develop the areas, there was low potential conflict and additional management requirements were not explored as part of the UWMP.

Figure 11 shows recent prairie dog colony mapping, and Appendix D provides descriptions of the colonies at the Reservoir. It is not uncommon for the size and location of Black-Tailed Prairie Dog colonies to fluctuate. In the mid-2000s, populations on both sides of the Reservoir experienced Sylvatic Plague outbreaks, which can cause significant declines, and they are currently rebounding at varying rates at different locations. The North Dam population now has a higher count than before the plague. A population on the North Shore also experienced losses from the plague and still hasn't rebounded. Colonies in some areas to the west of the Reservoir are rebounding and other areas in the west either never rebounded or are starting to decline again.

During the current assessment, Black-tailed Prairie Dogs were observed in riparian and wetland areas which are traditionally marginal habitat for them. As the OSMP Grassland Plan notes, "Although a native species, and an integral nested target for one of the Grassland Plan targets, the black-tailed prairie dog is a source of stress for other targets... Long-term monitoring on OSMP also indicates that prairie dogs degrade native plant communities, reducing graminoid (grass) cover and increasing cover by bare ground. Our conceptual models suggest that this increase in bare ground is related to the higher levels of weed cover typically associated with long-term prairie dog occupancy. In addition, prairie dog colonies have fewer of the species characteristic of OSMP grasslands. This may result from the inability of some of these species to endure the intense grazing and competition (with weedy plants) found in prairie dog colonies." For these reasons, the OSMP Grassland Plan provides designation criteria for Prairie Dog management areas that include Transition Areas that consider adjacent lands and Multiple Objective Areas where more than one conservation target is present (see Table 13 in Section 6 for management considerations at the reservoir).

4.7 Summary of Findings for Wildlife Surveys

The 2013 wildlife surveys identified the presence of many of the general mammals, amphibian, reptile and bird species that were expected to be present based on the habitat type. For example, Hammerson (1999) shows four species of turtles as present in Colorado and in Boulder County, the survey positively detected two (snapping and softshell). Similarly, of the eight snake species likely to occur in Boulder County, three were identified during the 2013 surveys. Given the shy and secretive nature of some of these species (e.g. Milksnake) it is not unexpected that others were present but not detected.

The small mammal species richness and diversity were unexpectedly low. One or more contributing factors could include:

- the lingering effects of the drought of 2012;
- recreational impacts from humans and dogs;
- regular population fluctuations;
- short vegetative cover height and amount ;
- direct or indirect influences of Prairie Dogs, and;
- disease may also be a limiting factor though there was no known disease outbreak during the 2013 surveys.

Bird survey findings identified the presence of 114 bird species, 82 of which were breeders. Of the total birds identified, 15 bird species of concern were found, including nine potential breeding species. Three American Bittern nesting territories were observed within the Dry Creek wetlands and a fourth American Bittern nesting territory was in the Coot Lake wetlands. Concerns raised by the bird survey include the absence of any evidence of Northern Harrier nesting for the second consecutive year; the absence of any burrowing owl observations; and the absence of American Bitterns in the Little Dry Creek drainage, where bitterns were observed annually seven out of the last ten years.

The 2013 wildlife surveys provide a snapshot of observations to serve as a baseline for future work. The surveys provided a representative sampling of the area overall as well as targeted locations. Wildlife presence/absence surveys can only result in the confirmation of presence (Gu and Swihart, 2003; Rhodes et al. 2006), and it was beyond the scope of the current study to count or estimate abundance of wildlife. Absence is not possible to confirm since a species could not have been present within the survey area at the time surveys were conducted but it was not detected. Therefore, the confirmed species list is expected to expand in the future with additional time spent monitoring.

5 RESOURCE AND RECREATION MANAGEMENT EVALUATION

This section identifies conservation priorities and assesses threats or issues that may affect the long-term viability of natural resources at the Reservoir. Recreation activities are evaluated in Section 5.2 to describe how specific activities can impact the natural resources, and Section 5.3 discusses current visitor patterns and carrying capacity considerations for the Reservoir.

5.1 Conservation Priorities

Conservation priorities or “targets” are the native ecosystems, communities or species that represent the biodiversity of a planning area. The long-term viability of these native plants and animals can be characterized by key ecological criteria including size, context, and condition. These criteria describe elements of the ecosystem that if missing would reduce its ability to regenerate and survive over time.

At the Reservoir, priority conservation targets include native plant communities –wetlands, riparian forest, and grasslands—along with focal wildlife species including native birds, amphibians, reptiles, and mammals as described in the preceding inventory discussion. The primary conservation targets¹¹ include:

- Mixed Prairie Mosaic
- Wetlands
- Riparian Areas
- Native Wildlife – including Small mammals, Amphibians & Reptiles
- Black-tailed Prairie Dog and Associates
- Bird Species of Concern (nested target in various plant communities)

As previously noted, the size and context of the conservation targets at the Reservoir are considered important within the City of Boulder and greater Boulder County. The Reservoir offers a large protected area with a major freshwater body, situated in a semi-rural setting near the edge of city development. Opportunities for successful natural resource protection and long-term viability are enhanced by its location at the interface between plains and foothills ecosystems and adjacent to protected OSMP lands that provide buffers as well as sources of vegetation and wildlife dispersal.

Indicators of condition include the composition or diversity of species, structure, connectivity and interactions, and extent of disturbance (non-natural) and non-native species. Condition descriptions are generally categorized as poor, fair, good, and very good to provide a relative, estimated ranking across sites or within an individual site. Descriptions of key indicators of condition used to evaluate the biological resources of the Boulder Reservoir are provided in Appendix E. These descriptions were developed from a combination of existing guidance and plans, background information on the site, and team collaboration.

Using the observations collected during the field inventory, Table 8 was prepared to summarize conditions by management zone (refer to Appendix E for additional detail). The overall site ranking column in Table 8 shows “averages” for an individual resource across all of the management zones. None of the resources were ranked in very good overall condition sitewide. Of the 13 resource categories, six were in good overall condition and six were fair: one category (small mammals) was poor. Because conditions vary significantly between management zones, however, the overall sitewide rankings tend to mask or average out high or low quality areas. Therefore, looking at individual ratings by zone is a useful way to highlight how zones compare to each other. and thereby identify *best opportunity areas* for prioritizing management.

As shown in Table 8, Dry Creek and Coot Lake had the highest quality conditions and ranked in good condition. Little Dry Creek, North Shore, South Dam, North Dam, and the Western Upland are all in fair condition. The South Shore had only poor and fair rankings due to its recreation focus. The presence of at least one good or very good indicator in all zones except

¹¹ Open water, though clearly a significant resource at the Reservoir, was not included as a conservation target for the current evaluation, because direct water management is not the responsibility of the Parks and Recreation Department.

the South Shore highlights the need to manage for specific goals and objectives in specific locations that have the best opportunity for a particular indicator as will be discussed further in Section 6.

Table 8 Ecological Conditions of Key Biological Resources at Boulder Reservoir
VG=Very Good (4); G=Good (3) ; F=Fair (2) , and P=Poor(1) ¹

	Condition by Management Zone								**OVERALL CONDITION
	Dry Creek	Coot Lake	Little Dry Creek	North Shore	North Dam	South Dam	South Shore	Western Uplands	
Native Wetland Herbaceous (WH)	G	G	F	G	G	P	P	G	G
Mixed Grass Native Prairie (MGPM)	F	NA	F	F	G	P	NA	G	G
Native Riparian (NR)	G	G	G	F	NA	NA	NA	NA	G
Native Woody Wetland (WW)	G	G	F	G	NA	NA	NA	NA	G
Birds: Grassland Nesting Species	F	F	P	P	F	F	F	NA	F
Raptors	G	P	G	P	P	P	P	P	F
Waterfowl and Grebes	VG	G	P	P	P	P	P	P	F
Birds: Waders & Shorebirds	VG	VG	VG	F	P	P	F	P	G
Percentage of native bird species	G	G	G	VG ²	G	VG ²	F	NA	G
Amphibians	F	F	P	P	P	P	P	P	F
Reptiles	P	F	P	P	P	P	P	P	F
Small Mammals	P	P	P	P	P	P	P	P	P
Carnivores	F	G	F	P	P	P	P	F	F
Zone Summary*	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	

1. Refer to Appendix E for descriptions of indicators; rankings by zone; and method for rating Overall Condition and Zone Summary.

2. These rankings are high due to the high percentage of urban adaptors (i.e., the numerator) in relation to the lower overall number of birds in these locations (i.e., denominator).

The current condition evaluation indicates that in 2013 the natural resources of the Reservoir ranged from fair to good, with the exception of the south shore (poor) which is not managed for natural resource values. Based on available historical information, long-term observations of team biologists, and habitat on neighboring properties there is evidence, however, that the natural resources have degraded in recent years. In the absence of consistent, detailed biological monitoring data, it is safe to assume that the current conditions of the natural resources of the Reservoir reflect, at least partially, from a combination of past agricultural activities, recent vegetation management practices, and recreation impacts as described more in the following subsection.

5.2 Recreation Impact Analysis Framework

Natural resources at the Reservoir—like elsewhere along the Front Range—are experiencing stresses from a number of current and pending threats including development, transportation, increasing disturbances from recreational uses, alteration

of ecological processes, invasive species, and climate change. The stresses on the resources include reduced reproduction, reduced native population size, increased abundance of urban adaptors (i.e., tolerant of disturbance), increases in invasive species, and fragmented or degraded habitat resulting in reduced food supply and reduced cover.

Specific sources of some of these stresses include:

- Visitor and vehicular disturbance due to proximity and noise particularly near nesting and forage areas,
- Domestic dog disturbance particularly off-leash and swimming near nesting and forage areas,
- Vegetation trampling from social trails and trail widening,
- Habitat fragmentation and loss from roads, trails, developed facilities,
- Water quality and pollution from direct discharge or offsite development and land use,
- Immigration of invasive species from direct transport, waterways, or dispersal from nearby properties,
- Monocultures in part from fire suppression, grazing pattern changes, and lack of active management
- Competition & predation by non-natives such as bullfrogs (and natives such as coyote).

The relative amounts and severity of the above impacts can vary depending on specific locations and times of year. Of the impacts associated with recreation at the Reservoir, visitor disturbances (including noise and events) and dogs appear to be posing significant sources of stress. Observations made during this study and interviews with Parks staff confirmed that trespasses into wildlife closure areas by humans and dogs are occurring on a year-round basis and in multiple locations at the Reservoir. Also, numerous event noise disturbances trespass, and model plane retrievals occur in the wildlife closure areas along 51st Street. Thus, offsite recreation and dispersal of “passive” recreation from the northern and western management areas create more impacts of concern to conservation targets than do the active recreational uses of the Reservoir (e.g., fishing and swimming) in the South Shore area.

The OSMF Grassland Ecosystem Management Plan also reported that “Recreational trails are correlated with elevated levels of mortality due to nest predation of nesting birds (Miller and Hobbs 2000). Biologists working on OSMF have also demonstrated that grassland songbirds avoid areas near trails for nesting; and nest survival decreases with increasing proximity to trails (Miller et al. 1998).”

Management practices can help mitigate some of the recreational impacts, but to date, city resources have been inadequate to keep up with the mounting pressures, let alone plan for resource maintenance and improvements in the face of impending future pressures as the population continues to increase. To meet the challenges ahead, the Site Management and Implementation Plans will need to ensure a long-term stewardship commitment and improvements to signage, education, monitoring, oversight, fencing, enforcement, as well as resource maintenance and restoration are discussed in Section 6.

5.3 Visitor Use Patterns

Information on recent visitor use patterns is available from the city’s 2009 visitor survey at the Reservoir, the 2012 Reservoir Master Plan, 2013 trail counter data, and the January 2014 Reservoir Open House. Review of this information suggests that dog walkers, beach picnickers, boaters, and community event attendees are main visitor use groups. Interviews during the 2009 visitor use survey revealed that scenic views and relaxation were key experiences people enjoyed in all of the visited sites. The South Shore is by far the most visited area (4,464 visitors per week), followed by Coot Lake (2,150 visitors/week) and the 55th Trailhead (1,394 visitors per week). However, the South Shore visitors return less often (4.6 visits/ month/user) as compared to 10.5 return visits/month/user at Coot Lake and 9.2 visits/month/user at the 55th Street Trailhead. Approximately half of the total visitors brought dogs to Coot Lake (1,274 out of 2,150 visitors/week) and the 55th St Trailhead (661 out of 1,392 visitors/week), and about 75% of the dogs were off-leash.¹²

¹² No information is available about how many of the off-leash dogs were in compliance with voice command regulations, but field teams report multiple observations of dogs apparently beyond the sight of their masters.

Existing trail usage occurs on designated multi-use and single use trails (refer to Figure 6) as well as social trails around the Reservoir. According to city estimates, there are 3.7 miles of primary trails, and 3 miles of secondary trails. However, because social trails have not been fully mapped, calculations of lengths and densities of trail types are not possible at this time. Overall, the increasing number of visitors, as well as the intensity and diversity of uses, appears to exceed the current management capacity. Preliminary observations of social trails nonetheless suggest that relative to its size, the North Shore has the highest density of social trails. This area has also been observed to be experiencing heavy trampling from the dog and pedestrian traffic.

Numerous special events occur at the Reservoir ranging in size from family reunions to large special events. The duration of the events may last from one hour to all day. The Master Plan reports that 35 events occurred in 2011 that attracted over 21,000 visitors. Neighbors report that noise and traffic are major concerns during the larger events. The Reservoir manager works with event planners to address these concerns, e.g., by positioning speakers and controlling volumes (but the effectiveness of the controls reportedly varies with individual conditions like wind direction).

5.4 Carrying Capacity Considerations

The current project included consideration of carrying capacity issues for the Reservoir. Carrying capacity is a term that has a variety of meanings depending on the context and user, and it does not have a set of standard or numerical definitions. The term originated in relation to estimating available food to support ranch or farm operations, and with the evolution of environmental awareness in the 1970s, the earth's carrying capacity was discussed in relation to human resource use or footprint. *Environmental carrying capacity* is generally interpreted to refer to the extent to which a resource can be used without a negative impact. *Recreational carrying capacity* refers to the visitor experience and the extent to which recreation can occur without negative visitor perceptions of crowding and impacts, as well as their use of coping mechanisms in crowded and impacted areas. In park settings, assessing recreational capacity is a complex and somewhat subjective endeavor that is directly related to a number of different carrying capacities, including physical (limits of actual physical space), facilities (capacity of parking lots, boat launches, etc.), historical, and social (limitations adversely affecting the visitor experience). Social capacity depends on perceptions of various user groups, over an extended time period, with an understanding of factors such as "floating baselines," i.e., when long-time users seek remote locations and new users do not have the historical or social perspective of previous users.

At Boulder Reservoir, we are cognizant of these several dimensions of determining recreational capacity and further believe it important to incorporate environmental carrying capacity as reflected in the biological resources of the area. Because Boulder Reservoir is dominated by natural areas, there are, by necessity, linkages between the recreational/social uses of the Reservoir and its biological resources. These include the creation of unplanned social trails through the Reservoir's ecosystems and the trampling that introduces disturbance and creates opportunities for weeds. The decibel levels reached by crowds attending special events can be disruptive to breeding and foraging birds and both large and small mammals. Car traffic can present a hazard to prairie dogs and other small mammals in particular, not to mention the discouraging effect it has on movement of fauna both large and small. These impacts, whether temporary or permanent, can have lasting impacts on the Reservoir biota. Based on the observations made during the current assessment, the increasing number of visitors, as well as the intensity and diversity of uses, it appears that the environmental carrying capacity of the reservoir is near being met if not exceeded at times.

If unaddressed, current impacts are likely to worsen in the future due to additional off-site development pressures, altered hydrology, climate change, and increased recreational pressures. For example, new trails are proposed along 55th Street and along the North Shore and the Lyons-to-Boulder Regional Trail is proposed for the area. Therefore, there is a critical need to ensure future use patterns are compatible with sustainable management of biological resources and to identify potential conflict areas and management strategies as described in Section 6.

5.5 Management Evaluation

The Reservoir Master Plan provided an overview framework for management and identified the following types of uses for different management areas: South Shore is Active Recreational; North Shore, Coot Lake, and West Shore are Passive Recreational/Natural; and North and South Dams are “Utility Dam Structure.” Table 10 expands on the basic framework from the Master Plan to summarize specific types of suitable visitor opportunities for each of the ecological management zones.

Currently, Parks staff notes that the Reservoir water itself is considered as part of the South Shore Recreation area, and Management issues arise because of the lack of enforcement around the entire shoreline. For example dogs are not allowed in the water from the South Shore from Memorial Day to Labor Day, but they are allowed in at the North Shore. As a result, some boaters have been observed to launch from the south without their dog, then go to the north shore to pick it up, and bring it to other parts of the Reservoir.

Off-season (September to May), Parks and Recreation staff do not have the resources to patrol the wildlife closure areas, and both staff and the biologist team reported that it was not uncommon to observe or find evidence of visitors and their dogs trespassing in the closure areas. The lack of gates, fencing, and adequate signage increases the opportunities to trespass into these areas. County enforcement officers have informed Parks staff that they are unavailable to assist the Parks with visitor management and wildlife issues unless a health and safety issue is involved.

Table 10 Suitable Visitor Opportunities By Ecological Management Zone at Boulder Reservoir¹

Type of Use from Master Plan	Active Rec.	Passive Recreation/Natural				Utility
	South Shore	Coot Lake ²	North Shore	Western Uplands	Dry & Little	North & South
Hiking/Walking Trails	√	√ Outside of closures	√	No to maintain buffer for Prairie Dogs.	No other than 51 st access to North Shore	√
Dog Walking	√ Except from Mem.. Day- Labor Day	√ Outside of closures	√ Voice/Sight/Off-leash allowed	No	No	√
Wading	√	No.	No, except to control dog.	No	No	No
Dog Swimming	No. Concerns about water quality.	√ Outside of closures	No	No	No	No
Picnics/ Social Gathering	√	√	√	No	No	√
Wildlife and Scenery Viewing	√	√	√	From road	From road	√
Running	√	√	√	No	No	√
Biking	√	√ Outside of closures	√	No	No	√
Swimming	√	No	No	No	No	No
Boating	√	No	No, ANS concerns	No	No	No
Fishing	√	From the shore only	√	No	No	√

Type of Use from Master Plan	Active Rec.	Passive Recreation/Natural				Utility
	South Shore	Coot Lake ²	North Shore	Western Uplands	Dry & Little	North & South
Parking/Access	√	East of 63 rd	√	No	No	No
Special Events ³	√	No	No	No	No	No
Education Opportunities	√	√	√	√	√	√

1 Note, these are general recommendations about suitability with the expectation that details about levels of use/intensity, specific locations within zones, and implementation considerations will be provided in the SMP.

2 Suitability is for eastern/developed portion of Coot Lake; closures refers to wetlands on west side.

3 Currently, events occasionally occur at locations other than the South Shore. It is recommended the SMP re-evaluate and address special events using a set of more detailed suitability criteria based on e.g., the timing, duration, specific locations and numbers participants in relation to threats to priority habitat types and goals.

A special consideration for the future management framework involves the need for improved management of the perimeter around the Reservoir particularly during special events. While many event managers work with the Parks and Recreation staff to reduce impacts, not every event is managed in the same way, and impacts to protected areas occur such as noise and trespass. For example, although the events are restricted to designated roads or trails, car parking and spectators frequently sprawl along 51st and 55th Streets in close proximity to wildlife closure areas. There are plans for a new trail alignment along the west side of the Reservoir to attempt to address safety and capacity concerns during the events. However, given the concentration of rare plants and birds and the physical constraints of the two creeks, it will be difficult to prevent or mitigate impacts to sensitive habitat from the new trail. Therefore, prior to moving forward with the proposed trail, Boulder Parks and Recreation Department should consult with the city Planning and Development Services about conditions that may be required for a city Stream, Wetland and Water Body Permit and the US Army Corps of Engineers about the 404 wetland permit requirements. Because a key goal of the wetland regulations is to avoid filling wetlands, the city will need to show a detailed analysis of alternatives to avoid impacts including, for example, an overpass bridge, and/or a feasibility assessment of alternative event routes, e.g., an eastern or southern loop, or relocation to an alternate venue. CPW, Boulder County, and OSMP should also be consulted for input into this alternatives analysis.

The upcoming Site Management Plan will clarify specific policies and programs for Reservoir activities. Strategies and recommendations that can be incorporated are provided in the following Section and will be further developed during the Management Plan process.

6 MANAGEMENT PRIORITIES AND OPTIONS

This section provides priority resource management goals, develops a framework for protection strategies and identifies management objectives to reduce threats and improve degraded systems in best opportunity areas. Section 7 describes the monitoring and adaptive management framework that will be used to measure the success of future implementation and the need for modifications.

6.1 Priority Resource Management Goals

Existing documents such as the Reservoir Master Plan, Boulder County Comprehensive Plan, the Urban Wildlife Plan and Grassland Ecosystem Management Plan, have presented goals (and objectives) that are potentially applicable to conservation targets at the Reservoir (Table 11)

Table 11 Conservation Goals in Relevant Planning Documents

Boulder Reservoir Master Plan
<i>Goal 3. Identify sensitive wildlife and plant species and protect, enhance and restore their natural habitat.</i>
3a. Conduct a biological species inventory-- Complete.
3b. Develop and implement wetland and grassland restoration and management plans. <ul style="list-style-type: none"> Identify noxious weed species and prioritize their eradication based on level of threat. Identify degraded areas and determine mitigation standards, costs and timelines to restore identified areas. Establish conservation goals for wetland and upland protection areas.
3c. Install fencing and/or visual barriers between trails and sensitive areas as appropriate to discourage direct disturbance of wildlife and promote protection of rare and declining wildlife species.
3d. Close "Jet Ski Cove" and place buoys near the Dry Creek inlet area to restrict boat access-- Complete.
3e. Work with the Colorado Division of Parks and Wildlife to coordinate enforcement and to establish fish size criteria for the Reservoir and Coot Lake to support a healthy aquatic ecosystem.
3f. Implement access and seasonal closure policies to protect nesting birds— In process.
3g. Update and expand interpretive and regulatory signage along trails near sensitive habitat areas.
3h. Work with local organizations and other educational institutions to monitor wildlife and plant species over the long term and to analyze population trends.
Boulder Valley Comp. Plan (2013)
B.1 Boulder County shall conserve and preserve environmental resources including its unique or distinctive natural features, biodiversity, and ecosystems through protection and restoration in recognition of the irreplaceable character of such resources and their importance to the quality of life in Boulder County.
B.2 Boulder County sustains and protects native species, natural ecosystems and the biodiversity of the region by designating High Biodiversity Areas, Natural Areas, Natural Landmarks, Significant Natural Communities, Critical Wildlife Habitats, Species of Special Concern, Wetlands, Riparian Areas, and Rare Plant Areas.
B.3 Boulder County shall promote the viability and integrity of all naturally occurring ecosystems and their native species populations by applying a variety of environmental resources management strategies in a manner that is consistent with current ecological principles and sustainable conservation practices.
B.4 Boulder County recognizes that climate change is having significant impacts on our environmental resources. As the body of climate science knowledge grows and potential effects are better understood, Boulder County shall incorporate the best scientific information into planning and decision-making to adapt to and offset those impacts.
B.5 Boulder County shall continue to protect air, water and soil resources and quality, as well as restore resources in a degraded condition to enhance overall environmental health.
B.6 Boulder County shall continue to protect prominent natural landmarks and other unique scenic, visual and aesthetic resources in the county.
B.7 Boulder County shall conserve and preserve Environmental Conservation Areas (ECAs) in order to perpetuate native species, biological communities, and ecological processes that function over large geographic areas and require a high degree of connectivity to thrive.
B.8 Boulder County shall protect environmental resources both at the site-specific scale and landscape scale through a variety of means such as partnerships with private landowners, nongovernmental organizations, and other governmental agencies; education and outreach; advocacy at the state and federal level; and other programs consistent with the goals and policies of the Comprehensive Plan.
Urban Wildlife Management Plan –Black-Tailed Prairie Dog Element
Long Term Protection of Prairie Dog Colony near North and South Dams. Manage Near Term Removal from 100-200 feet at base of dams/buffer areas under Agreement with Colorado Northern Water Conservancy District to protect dam safety and planned development near of Fire Training Center, south dam. Refer to Plan for more details about city's UWMP principles and practices.
OSMP Grassland Ecosystem Management Plan
1.1 By 2019, establish prairie dog, prairie dog commensal and prairie dog predator populations and population distribution within the range of acceptable variation.
1.2 By 2019, increase the bird conservation scores to at least 3.9 for the Mixedgrass Prairie Mosaic and Xeric Tallgrass Prairie.

1.3 By 2019, increase the frequency of singing male grasshopper sparrows in habitat blocks over 247 acres (100 ha) in the Mixedgrass Prairie Mosaic to 60%.
2.1 By 2019, reduce non-native plant species in Best Opportunity Areas of the Xeric Tallgrass Prairie, Mesic Bluestem Prairie, and Mixedgrass Prairie Mosaic targets to achieve at least a “Good” rating for prevalence.
2.2 By 2029, achieve “Good” rating for all vegetation composition and structure indicators in Best Opportunity Areas.
2.3 By 2019, increase fire frequency so that 50% of Upland Grassland Complex and Mesic Bluestem Prairie Best Opportunity Areas will have burned within the acceptable fire return interval.
3.1 By 2019, evaluate and restore riparian hydrology in Best Opportunity Areas.
3.2 By 2019, evaluate and restore wetland, riparian and aquatic habitat in Best Opportunity Areas.
3.4 Prevent an increase in the extent and diversity of aquatic nuisance species in the Grassland Planning Area.

In keeping with the existing Plans and based on the information collected in this assessment, the following four priority goals are proposed (in no particular order) for the conservation targets at the Reservoir:

- Goal 1: **Maintain or expand the size of existing native** wetland, riparian, mixed grass prairie plant communities.
- Goal 2: **Improve the condition of native** wetlands, riparian and mixed grass prairie grassland communities in best opportunity areas.
- Goal 3: **Restore degraded, non-native** grassland and riparian habitats to eliminate non-native elements, establish buffers, and improve connectivity in best opportunity areas.
- Goal 4: **Protect wildlife habitat to support species of concern and a diversity** of native birds, amphibians, reptiles, and small mammals.

Supplemental goals may be added in the future as additional information becomes available through monitoring e.g., for specific habitat needs of birds, mammals, or plant species of concern.

6.2 Protection Strategies Framework

A strategic framework is proposed here to establish the levels of protection that will be needed to achieve the goals listed above. As shown in Table 12, ecological management zones are identified as best opportunity areas for maximum, moderate, or minimum protection to assist with reducing the risk of current and future recreation impacts. These designations are based on the evaluation of the conservation targets (refer to Section 5.1) and the interrelationships of communities and habitat types within and between zones¹³. For example, zones with large patches of high quality native vegetation or combinations of habitat types that form a mosaic and provide significant wildlife habitat are the best opportunities for maximum protection. Areas of mixed or non-native vegetation on or near good quality areas represent moderately impacted areas suitable for moderate protection. The South Shore with its high recreation and low habitat value is a minimum protection strategy area.

**Table 12 Matrix of Protection Strategies
to Minimize Recreational Impacts by Best Opportunity Areas**

Recreational Activity	Maximum Protection : Dry Creek, Little Dry Creek, Western Uplands, Coot Lake Wetlands (west side)	Moderate Protection: Coot Lake (east side), North Shore, North Dam and South Dam	Minimum Protection: South Shore
Hiking and dog walking	Year-round closures, fencing and gates, ranger patrol, education signage and outreach. Restoration and improvements of historic and existing impacts, e.g., from social trails	Vegetative barriers, ranger patrol, education signage and outreach	Signage and outreach
Special Events	Maintain trail and wildlife closures, restrict vehicle parking, and spectator locations, education and outreach, noise control	Select trail closures; education and outreach	Education and outreach
Biking	Year-round trail closures, ensure trails are located away from sensitive or critical habitats, restoration, ranger patrol, education signage and outreach	Seasonal trail closures, closures of higher-functioning or sensitive habitat, ranger patrol, education signage and outreach	Education signage and outreach
Boating	Establish buffer zones and setback	Investigate chemical pollution; disallow	Investigate chemical pollution;

¹³ Refer to OSMP's Grassland Plan for further discussion of types of considerations used for Best Opportunity Analysis.

	distances to protect wetland, riparian, and shallow-water ecosystems and bird breeding and foraging areas; ensure hourly use is restricted to diminish noise pollution; investigate chemical pollution; disallow vehicles leaking any fluid	vehicles leaking any fluid. No boats in Coot Lake.	disallow vehicles leaking any fluid
Swimming	Prohibit swimming.	Prohibit swimming.	Allowed and provide resource education signage and outreach
Fishing	Prohibit fishing.	Restrict equipment to hook and line gear; prohibit lead sinkers; educate anglers on humane handling of fish for catch & release	Education signage and outreach.
Parking Access	Prohibit parking within established distance of high quality habitat	Allow parking in designated locations and for certain events	Allowed parking and shuttle services for events

6.3 Management Objectives and Recommended Approaches

This section outlines management objectives and recommended approaches for each conservation target at the Boulder Reservoir site based on applicable goals and the protection framework for recreation activities, described in the previous subsections. The recommendations are general actions to achieve the objectives, and they are not intended to be highly prescriptive, as specific prescriptions and schedules will be developed by City of Boulder Parks and Recreation staff as part of the Site Management Plan.

The recommended approaches in Table 13 will be further prioritized during the management planning process based on protection strategies for best opportunity areas and available operating expenses. Successful stewardship will require a long-term financial commitment, but it was beyond the scope of the current study to conduct a financial analysis to estimate the need for upcoming improvements. Interviews with Parks and Recreation staff at the Reservoir suggests that 3-4 additional full time employees would help meet the current shortfall in help training, maintaining, and enforcing natural resource protection and recreation management. Of these, at least one person could be tasked as a full-time lead, field conservation staff to assist with managing implementation and data collection.

It is understood that implementation of these recommendations is not uncomplicated, such as changing social trails to more desirable locations. However, there are numerous opportunities for efficient and effective improvements. Collaboration with OSMP could help the Parks and Recreation Department streamline implementation, as OSMP is in the process of implementing their Grassland Management Plan and can advise on approaches for Boulder Reservoir based on their relevant experiences. Ultimately, these recommendations are intended to provide a starting point for discussion for managers and, ideally, an educational tool for users.

Table 13 Management Objectives and Recommended Approaches For Boulder Reservoir Conservation Goals

Conservation Issues/Threats	Management Objectives	Recommended Approach
Goal 1: Maintain or expand size of existing native wetland, riparian, and mixed grass prairie mosaic plant communities.		
Invasive weed species encroachment occurs in native plant communities.	Reduce extent, abundance and diversity of invasive species.	Eradicate list A species (Purple loosestrife and Mediterranean sage) and continue annual program to reduce abundance of other priority noxious weed species (see Table 3) using Integrated Pest Management where possible.
Disturbances/trampling from trespass by humans and dogs.	Minimize adverse effects of current and future trail use, close selected existing social trails, and prevent establishment of spontaneous social trails.	<p>Restrict active and passive recreation activities that could reduce size through trampling. Increase fencing, gates, signage along perimeters of Dry Creek and Little Dry Creek zones, including along road, 51st Street trail, and parking area. Increase awareness of value of native plant communities through education and outreach.</p> <p>Hire ranger to patrol native communities and engage in <i>year-round</i> active management of visitors and enforcement of dog control. At a minimum, employ patrols during weekends and in areas slated for maximum protection.</p>
Habitat fragmentation occurs where road divides the Reservoir wetlands and drainages from areas to west.	Increase connectivity and prevent future fragmentation from new trail development.	<p>Assess feasibility of avoidance e.g., through alternative trail route or alternate locations for activities and facilities</p> <p>Work with partner agencies such as OSMP to discuss possible ways of expanding the extent of marsh area within the Dry Creek wetland, both upstream and downstream from N. 53rd St.</p>
Prairie Dog encroachment into drier portions of wetland is occurring around west edge and along Dry Creek.	Balance the needs of multiple conservation targets	<p>Work with city Wildlife Coordinator and OSMP to apply the designation criteria in the Grassland Ecosystem Management Plan to define prairie dog management criteria for colonies on the west side of the Reservoir.</p> <p>Assess the potential to re-establish the moisture regime and/or establish buffers, (e.g., using physical barriers) to protect the vegetation in Dry Creek and Little Dry Creek wetland and riparian areas</p>

Conservation Issues/Threats	Management Objectives	Recommended Approach
Goal 2: Improve the condition of native wetlands, riparian and mixed grass prairie grassland communities in best opportunity areas.		
Diversity in native plant communities is only fair to good despite importance of area on city and county scale. Dominant native indicator species are often limited to 1-3 species Invasive species are often codominant.	Identify and enhance priority vegetation patches based on their size, extent of monoculture, and habitat values (uniqueness, connectivity, etc.).	Increase native diversity by seeding additional native species such as blue grama and needle and thread in mixed grass prairie; and milkweed, bulrush, and sedges in wetlands Increase diversity and size of riparian areas by planting other native species such as peachleaf willow, box-elder, chokecherry, Woods' rose, snowberry, and currant. Develop strategic weed management plan with focus on reducing occurrences, early and often, particularly in wetland plant communities in Dry Creek, Coot Lake, and Little Dry Creek.
Altered fire and wildlife grazing (natural disturbances) regimes	Decrease cover of non-native species in best opportunity areas that will benefit most from improvement.	Develop plan for pilot scale prescribed burn for cattails in Little Dry Creek and Dry Creek.
Altered flows due to impoundments in upstream portions of Dry Creek and Little Dry Creek may be causing negative impacts, e.g., reduced low flows during droughts	Increase low flows and/or increase extent of seasonally saturated soils e.g., in arctic rush areas exhibiting signs of drying	Evaluate potential to improve hydrology and sediment transport issues along drainages. Explore possible locations for shallow rock "media lunas" to slow drainage and encourage infiltration.
Goal 3: Restore degraded, non-native uplands and riparian habitat.		
Non-native upland comprises 33% of the area of the Reservoir.	Restore native species diversity in uplands, beginning with maximum protection areas followed by moderate protection areas. Within these areas, start with patches that are easily reclaimed, and/or connect to existing good patches.	Prioritize restoration of grasslands in areas outside of established Prairie Dog colonies (and as opportunities arise following plague outbreaks) to create buffer around wetlands and connections between other native communities
Non-native riparian areas contain Russian-olive and tamarisk which are highly invasive	Eliminate non-native riparian plant communities.	Eliminate nonnative trees (Russian-olive) from riparian areas and replant with native species suited to the clay and clay loam soils. (In grasslands, no replacement necessary)
Bare ground and eroded areas from social trails is evident particularly in the North Shore.	Close social trails and maintain designated trails so that soils are stable and trampling and erosion areas do not occur.	Rationalize trail system (including relationship of social trails to new and planned trails) and obliterate redundant/unnecessary trails. Repair eroding trail, revegetate with native species, fence off during establishment. Provide education signage to protect restoration areas.

Conservation Issues/Threats	Management Objectives	Recommended Approach
Goal 4: Maintain wildlife habitat to support species of concern and a diversity of native birds, amphibians, reptiles, and mammals		
Trespass, event noises and aeromodel activity can impact Northern Harrier nesting success since they are ground nesters particularly vulnerable to disturbance by roaming hikers and dogs.	Protect sensitive breeding bird habitat from disturbance by human activities ¹⁴ and their pets throughout April-August nesting season	<p>(See Appendix C Table 18 for additional items)</p> <p>Establish 400 m buffer as reasonable minimal distance from Northern Harrier known or suspected nest locations.</p> <p>Re-institute the dogs-on-leash regulation on trail surrounding marshes during Northern Harrier nesting season (April-August), or until observations determine that harriers aren't nesting or have fledged the site) including on the trail encircling the wetlands west of Coot lake. Heighten enforcement of dog regulations.</p> <p>Close social trails and erect fences or rock barriers to discourage users and pets from wandering off trail Reduce areas of trampled ground and invasive weeds surrounding lake and marsh.</p> <p>Expand the areas of protected cattail marshes and surrounding wetlands. For example, Lower Dry Creek west of 51st could be added to closure areas. Consider opportunities to relocate model airport.</p>
Roughly half of the American Bittern nesting habitat in the county is in the wetlands around the Reservoir, including Coot Lake where off-leash dogs can roam.	Protect sensitive breeding bird habitat from disturbance by human activities ¹⁵ and their pets throughout April-July nesting season.	<p>Limit human and domestic dog encroachment within 200 m of any active American Bittern nests to protect them from disturbance.</p> <p>Expand the areas of protected cattail marshes and surrounding wetlands. For example, Lower Dry Creek west of 51st could be added to closure areas. Consider opportunities to relocate model airport.</p> <p>Plan for ranger (city staff and/or volunteer naturalist) to improve enforcement of wildlife closures. Restrict human traffic passing near the Little Dry Creek and Dry Creek wetlands on the existing road right-of-way.</p>

¹⁴ It is not recommended that additional Osprey nesting platforms be erected on Boulder Parks and Recreation managed lands surrounding the reservoir. Though Ospreys prey primarily on fish, they are opportunistic feeders (Poole, Bierregard, and Martel 2003) and their presence close to the reservoir shoreline may discourage foraging and nesting by native waterfowl and shorebirds while also disturbing nesting Northern Harriers.

¹⁵ It is not recommended that additional Osprey nesting platforms be erected on Boulder Parks and Recreation managed lands surrounding the reservoir. Though Ospreys prey primarily on fish, they are opportunistic feeders (Poole, Bierregard, and Martel 2003) and their presence close to the reservoir shoreline may discourage foraging and nesting by native waterfowl and shorebirds while also disturbing nesting Northern Harriers.

Conservation Issues/Threats	Management Objectives	Recommended Approach
Burrowing owls have had low fledge rates of nests during the past 20 years in Boulder County, possibly caused by predation	Protection and conservation of prairie dog colonies around the Reservoir may contribute to future burrowing owl nesting success, especially if prairie dog colonies are relatively large and buffered from disturbance.	Identify high-value burrowing owl nesting areas either as a research project for a student or with volunteer resources. Protect areas where burrowing owls are known to occur with the intent of increasing nesting opportunities. Promote awareness of burrowing owl habitat needs to garner public support and facilitate enforcement.
Overall habitat quality for multiple groups of native species could degrade due to recreation impacts and invasive flora and fauna.	Maintain/improve good quality habitat, with the long-term, overall objective of maintaining suitable habitat for diverse assemblage of native and/or sensitive wildlife.	Promote increased awareness of habitat values and issues and develop education and outreach as part of management plan. Implement vegetation and bird monitoring programs, either by staff or by volunteers. Pilot test guided tours of wetlands for nature program to be led by city staff and/or volunteer naturalists. Assess feasibility & effectiveness of bullfrog control, and continue with invasive plant control programs. Develop adaptive management approach based on monitoring results.

Additional details about priorities for nesting bird habitat and burrowing owl habitat enhancement and conservation are provided in Appendix C.

Details about specific polygons to restore or improve, native species, timing, and maintenance will be specified in the Site Management Plan.

7 MONITORING PROTOCOL

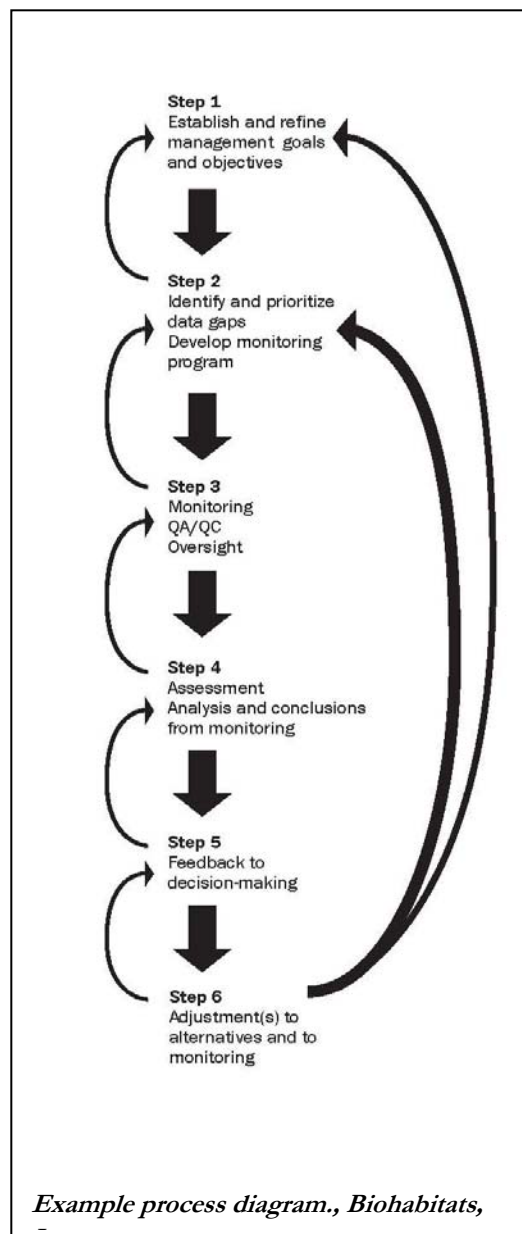
Monitoring will be used to (1) provide measures of success, (2) understand if the conservation strategies are driving toward effective conservation, and (3) revise, improve, and share information on the efficacy of different strategies.

7.1 Adaptive Management Framework

An adaptive management framework will be used to apply information gathered during monitoring for decision-making. This approach is established at the outset as a way to continue to respond to the dynamics of ecological systems and changing maintenance or stewardship needs over time. As such successful adaptive management requires an ongoing, long-term commitment to the iterative process (see example diagram, at right). As shown in the diagram, the goals and objectives and priorities developed in this assessment lay the foundation for the program. The monitoring protocol described in Section 7.2 will be targeted to address specific needs for management. Two general types of adaptive management —passive or active--may be implemented depending on the conservation target and monitoring constraints. More passive adaptive management occurs where the decisions are based on management objectives given the current information state and no change in practice occurs as long as trends are in the desired direction. More active adaptive management will use pilot projects to assess effectiveness of approaches and attempt to understand and respond to thresholds or action criteria. For example, to test the effectiveness of barriers to establish buffers, replicate areas could be designed to observe effects with and without the barriers. Or, similarly, variations in fencing could be tested to view effects on re-vegetation and invasive species. Barrier designs could then be modified and re-tested to improve effectiveness.

7.2 Monitoring Methods

Monitoring techniques are described for vegetation and wildlife to assist city Parks and Recreation staff in managing the terrestrial resources at the Reservoir. These methods should be included in the Site Management Plan along with additional topics that were beyond the current scope. For example, water resource and ANS monitoring are not included here as other city and State Water quality staff are actively involved in managing this resource. Suggested recreational monitoring is included here to gather additional resource protection information. However, the current biological assessment is focused on conservation targets, and did not establish recreational targets for visitor experience which the city may also want to monitor and include as a goal in the comprehensive Site Management Plan.



7.2.1 Vegetation Monitoring

Future vegetation monitoring will include two approaches – plant community mapping updates and more detailed observations of vegetation transects. The purpose of the surveys will be to confirm the size of native plant community areas is being maintained and that the quality is not degrading. Restoration areas will also be monitored to confirm establishment and the potential need for followup treatments.

The vegetation surveys should include:

- Reconnaissance-level mapping of the plant communities using methods much like the 2013 surveys. At a minimum, select updates could be conducted every 5 years in maximum protection areas – Dry Creek, Little Dry Creek and the Western Uplands and every 10 years in the Moderate Protection Areas (i.e., all other areas with the exception of the South Shore).
- Point-intercept transects, in areas to be determined in coordination with the city, duplicating OSMP methods. Transect data can be used to calculate species richness; relative cover of non-native species, Noxious Weeds, species of concern, and bare ground.
- Qualitative observations of areas of potential habitat for Fish and Wildlife Service Listed Species for plains areas of Boulder County, anticipated to include Ute ladies'-tresses orchid, Colorado butterfly plant, and Bell's twinpod.

Wetland delineations may also be required for future permitting processes, and the results could be integrated into the vegetation mapping as available.

Vegetation transects are recommended in accordance with the monitoring program currently underway by OSMP. If possible, the transect surveys should be synchronized with the OSMP monitoring to facilitate general comparisons. The number and location of transects can be refined in collaboration with city staff, but should focus on native plant communities within the best opportunity Maximum Protection zones and to a lesser extent in the Moderate Zones. These data may be collected at five-year intervals, or more frequently as needed, by City of Boulder staff, contractors, citizen science initiatives organized by the city, or one or more volunteer groups. At the end of the five-year monitoring period, the management objectives and monitoring frequency should be revisited to compare results with OSMP monitoring of grassland communities and to determine the most appropriate future sampling regime.

In addition to monitoring native plant communities and species diversity, city Parks and Recreation staff should consider partnering with CNHP and/or volunteers to assist with further identification of potential habitat for T&E species. In areas where a population of a rare species is known or suspected (per County Plan), managers may elect to utilize a private source for monitoring and limit publicizing the information.

7.2.2 Wildlife Monitoring

Wildlife monitoring will cover mammal and amphibian/reptile surveys as well as bird surveys. Generally speaking, small mammal surveys are most effective when conducted for two consecutive years every five to ten years. As such, we recommend additional small mammal surveys in 2014 in most of the same locations sampled during the 2013 surveys as well as additional surveys bisecting Dry Creek and Little Dry Creek (east of the 51st St). This monitoring will help detect population trends and will allow for adaptive management actions to prevent long-term population impacts. TVES surveys should be conducted every 5-10 years to help maintain a current species list for the Boulder Reservoir. The presence of Bullfrogs is of concern. To determine if native species are decreasing because of the Bullfrog, additional sampling using an approved methodology (call surveys or the North American Amphibian Monitoring Program protocol) is recommended. Surveys should be conducted in 2014 to determine population size for comparison in the future.

Birds. The existing annual breeding and migratory bird surveys should be continued with a focus on species of special concern. Additionally, it is recommended to begin an annual program for migrating and wintering water bird populations at the Reservoir to be conducted by volunteers. Results can be used to designate safe havens for migrating and wintering waterbirds

Recreation. Motion detector trail cameras are recommended to conduct a study of the current and proposed dog leash patterns (including documenting compliance), though these may need to be supplemented with, e.g., volunteer surveyors, to capture a broader range of observations. Similarly, cameras and/or volunteer monitors should be used to conduct a study of disturbances in closed areas during events and weekends to try to identify patterns of trespasses. Visitor surveys could be implemented at 5 year-intervals and in priority locations around Dry and Little Dry Creeks and Coot Lake.

Qualitative data collection could be obtained to assess visitor perception to policies and their experience, and this survey effort could be collected by volunteers. This information would be particularly valuable to identify key factors influencing behaviors such as: how the visitor experience is affecting use patterns; public understanding of how recreation impacts the ecological values; compliance with pet restrictions and respect for wildlife closure areas. Work at other recreational facilities has shown that as visitor use increases, crowding (based on number of people per unit area) causes people to seek out less dense experiences. As those visitors shift their use to less crowded areas or times, the concept of a 'floating baseline' becomes apparent as unsatisfied visitors no longer visit crowded areas while new visitors replace them, thus making it difficult to gauge visitor perceptions of crowding or impacts to the environment. This trend can be expected to put ongoing pressure on the currently high value habitat areas.

7.3 Response Actions

Results of the monitoring described above will be compared to baseline results presented here to identify trends in indicator species and serve as measures of improvement or degradation. Wildlife Management Indicator Species (MIS) are those animal species that best represent a group of species with special habitat requirements. Generally, species identified as MIS include at least:

1. Endangered, threatened, or special status species;
2. Species with special habitat needs that may be influenced significantly by planned management activities;
3. Game species (fish and wildlife) whose numbers are annually tracked;
4. Animals with very limited distribution.

For small mammals we currently recommend using the Deer Mouse as an MIS. As noted previously, Deer Mice are common species that flourish in disturbed habitats in which other species have a reduction in habitat suitability and thus occur in low numbers. Additionally, since some raptor populations can track vole populations in an area, small mammal results should be compared to bird survey trends, especially for Northern Harriers, to observe evidence of such trends¹⁶. Based on 2013 survey, we recommend using Western Chorus Frogs and Bullfrogs as MIS for amphibians. Management actions will be based on an increase or decrease in either species (an increase in Western Chorus Frogs should relate to a decrease in Bullfrogs). Enlisting the help of wildlife biologist graduate students may contribute to a better understanding of predator-prey relationships at the Reservoir.

Based on the results of the 2013 survey, bird MIS species would include all 9 of the breeding species of concern as well as Burrowing Owl. In addition, population estimates of common avian species using Distance sampling (a species must be common in order to have sufficient detections to generate a population estimate) are recommended to indicate certain species that are representative of specific habitat types. For example, the Red-winged Blackbird (*Agelaius phoeniceus*) could be used to indicate the health of wetland habitats. Bird monitoring results that indicate disturbances or nest failures will be used to re-evaluate closure times, barriers, education, restoration efforts, and enforcement methods to be applied the following year. Monitoring results will be reviewed to identify downward trends and potential shifts conservation target status to a lower ranking in a zone (See definitions in Appendix E.) Possible response actions are listed in Table 13 (and Appendix C, Table 18).

¹⁶ According to NatureServe resources, "Because nest density may track small mammal populations, a decrease in the number of nesting birds may be the result of a low vole year and not the beginning of a serious decline, provided that habitat availability remains constant (Serrentino and England 1989)."

Vegetation monitoring at the Reservoir will be used to identify changes in the distribution, size and condition of native plant community types as compared to the 2013 survey. Decreases in native plant communities of more than 5% during the first five-year period will serve as an action criterion to increase the frequency of mapping in that zone to every 2 years. If after the second mapping in areas of decreasing native communities confirms further declines, review of possible sources of impacts will be conducted and response actions will be implemented. Response actions will be in accordance with the recommended approaches in Table 13 for improvements and restoration (Goals 2 and 3).

For vegetation, indicator species are listed in the Condition Table in Appendix D for specific communities and include cattail (*Typha* sp.), bulrush, rushes, and sedges as indicators of wetlands; willow (*Salix exigua* and *S. amygdaloides*) and; and plains cottonwood (*Populus deltoides* subsp. *monilifera*) as wooded riparian indicator species. Western wheatgrass and possibly buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*) are indicator species of the mixed grassland prairie mosaic. .

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Stephen Jones is an independent environmental consultant who has completed more than two dozen breeding bird surveys for the City of Boulder and Colorado Parks and Wildlife since 1989. He has monitored Bald Eagle nests for Longmont Parks and Open Space and a number of private companies since 2003. Since 2004, he has trained Boulder Parks and Recreation volunteers to monitor nesting bird species of special concern in wetlands surrounding Boulder Reservoir and has submitted annual reports summarizing those monitoring efforts. He also organized and helped carry out the 1983-2014 Boulder County Nature Association wintering raptor surveys and an ongoing countywide Burrowing Owl survey for Boulder County Parks and Open Space and helped organize and carry out the Colorado Breeding Bird Atlas I and II projects. He is author of *The Last Prairie, a Sandhills Journal*, and co-author of *Peterson Field Guide to the North American Prairie*, *Colorado Nature Almanac*, *Wild Boulder County*, *The Shortgrass Prairie*, and *Butterflies of the Colorado Front Range*.

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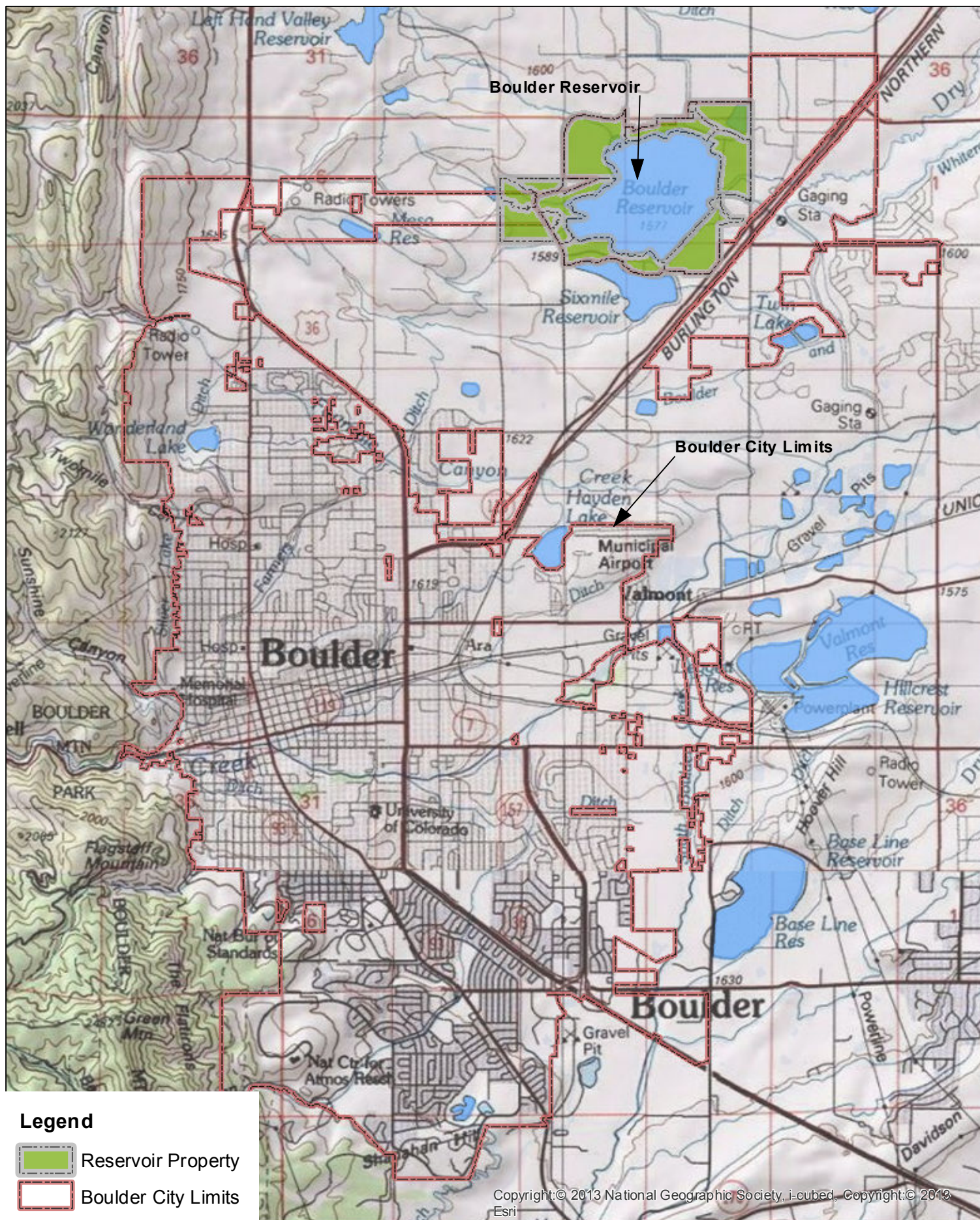
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¹⁷ For full list of references for Bird Survey sections please refer to Literature Cited in Appendix C.

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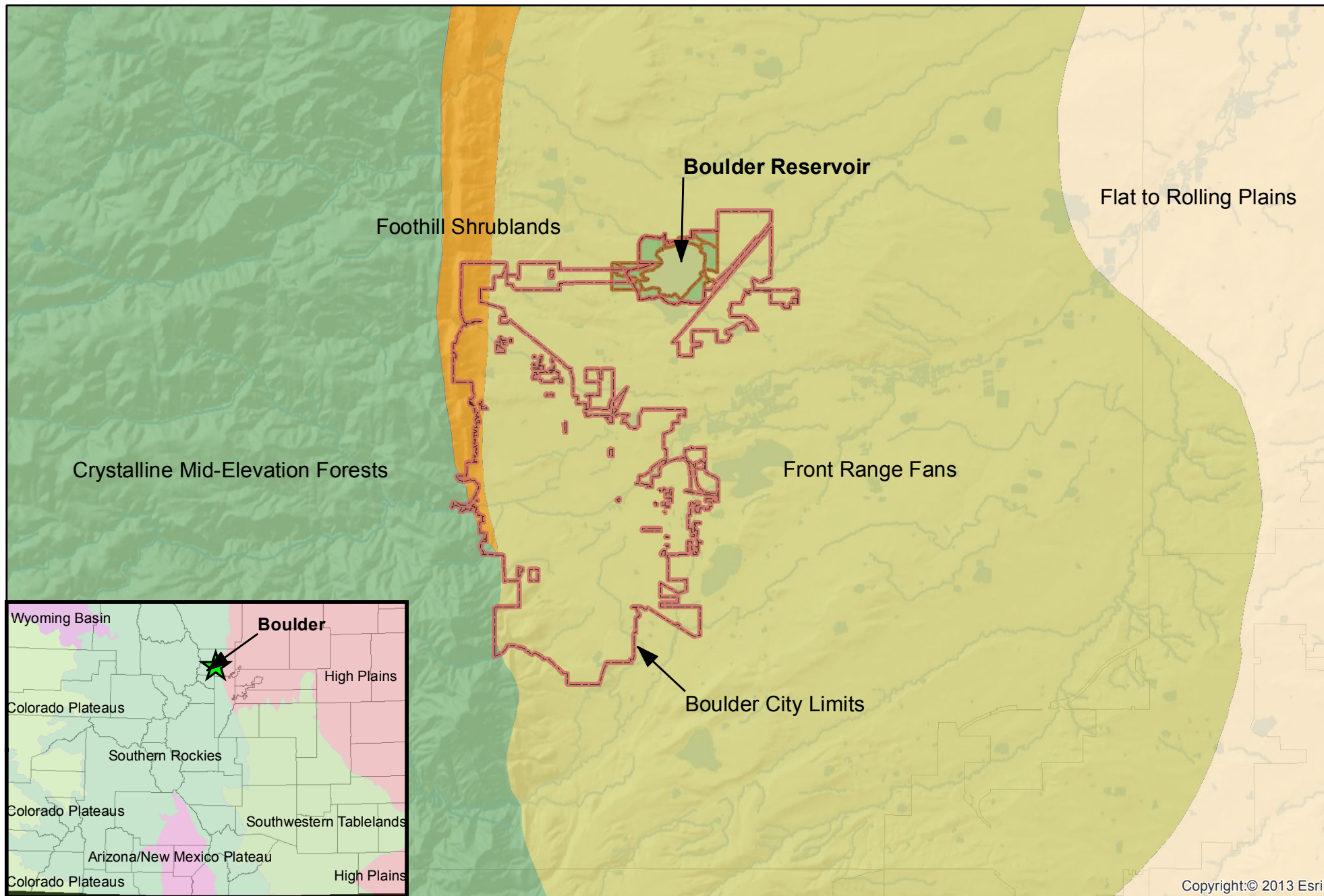
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0 1 2 Miles



FIGURE 1
LOCATION AND TOPOGRAPHY
BOULDER RESERVOIR

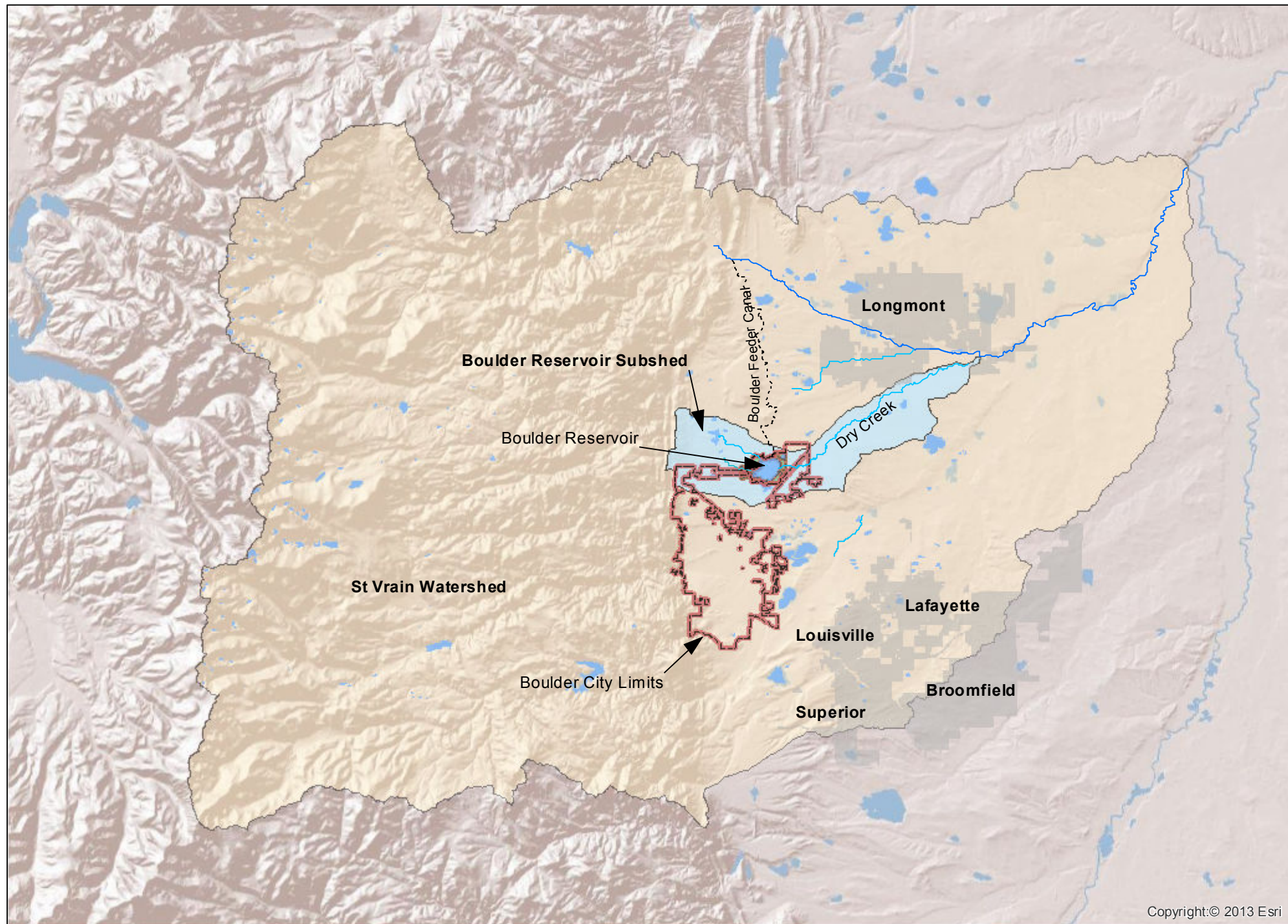


Source: US EPA Ecoregions of Colorado

0 1 2 3 4 Miles



FIGURE 2
ECOREGIONAL SETTING
BOULDER RESERVOIR



Copyright:© 2013 Esri

0 5 10 15 20 Miles



FIGURE 3
WATERSHED AND SURFACE WATER FEATURES
Boulder Reservoir

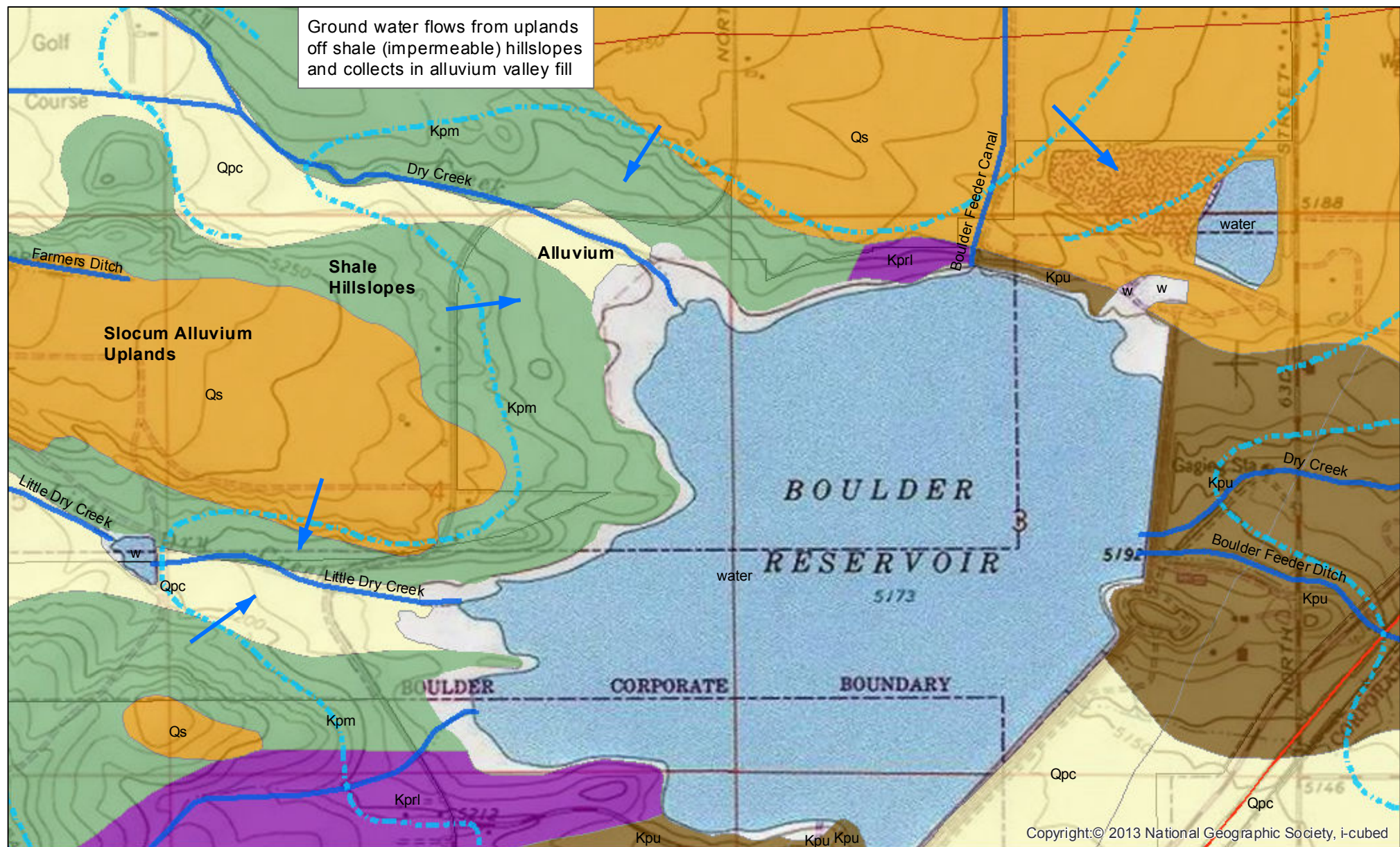
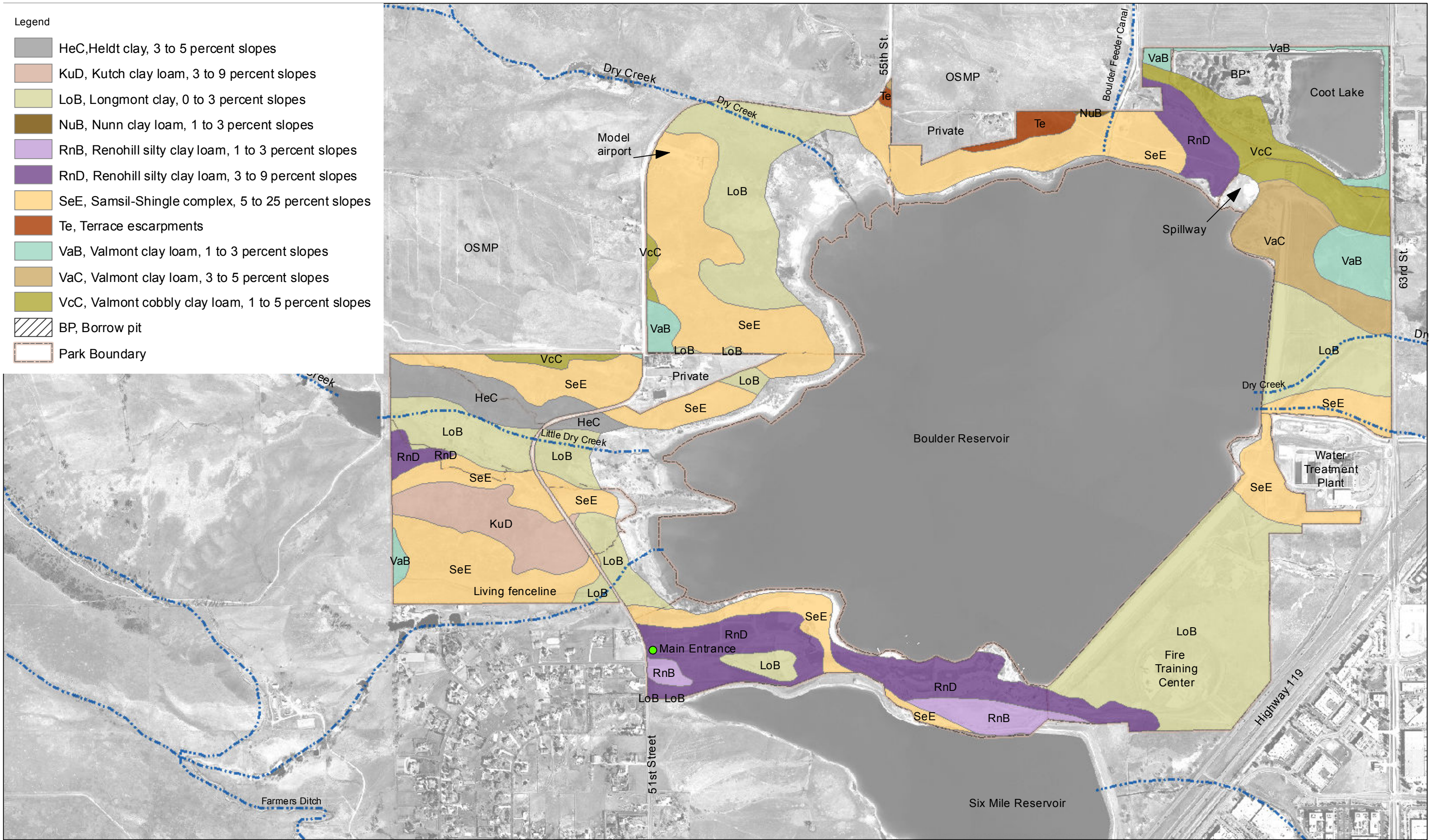


FIGURE 4
GEOLOGIC AND GROUNDWATER FEATURES
BOULDER RESERVOIR



Source: U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey Geographic (SSURGO) database for Boulder County Area, Colorado, CO643



FIGURE 6 -- RECREATIONAL FEATURES
BOULDER RESERVOIR

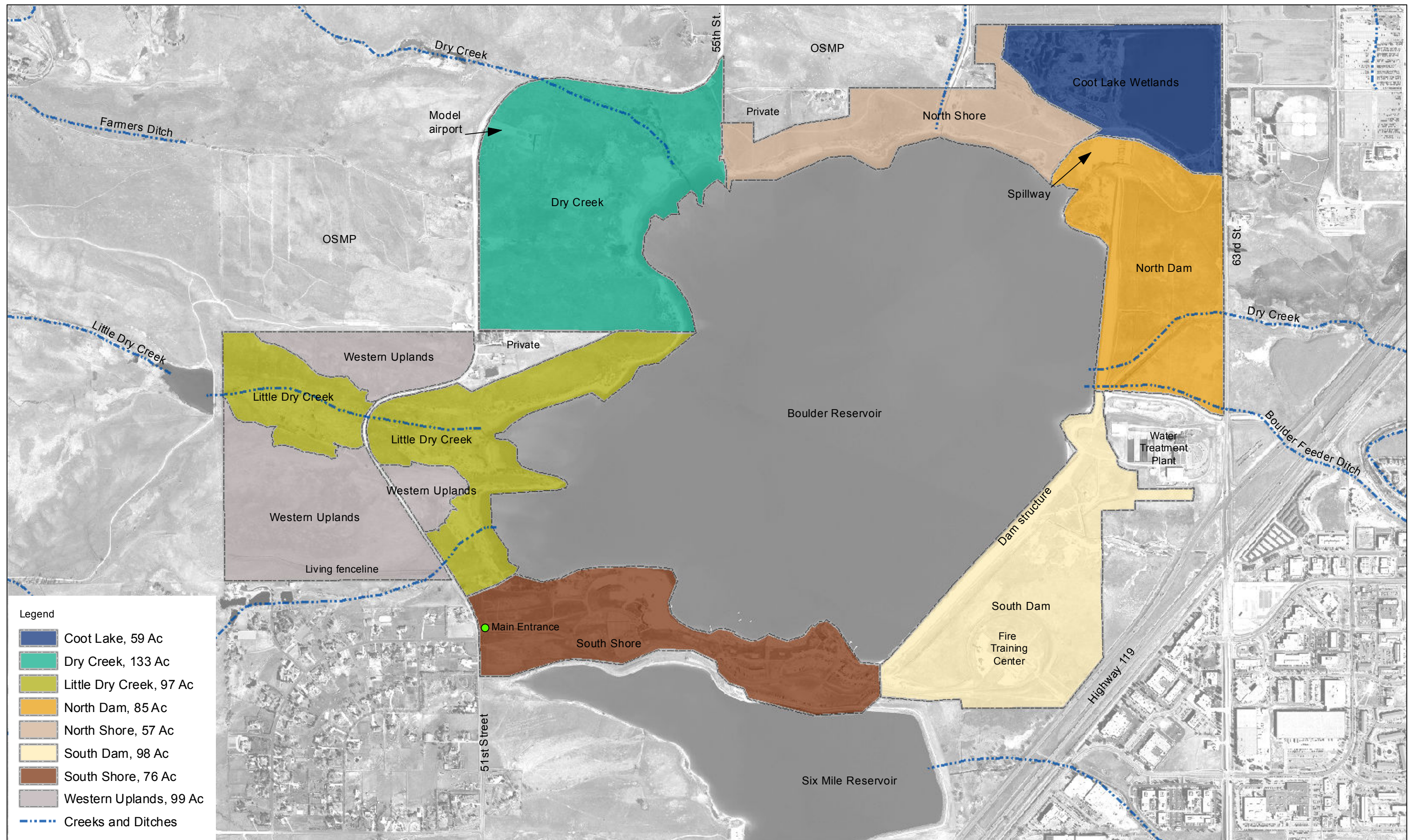


FIGURE 7
ECOLOGICAL MANAGEMENT ZONES
BOULDER RESERVOIR

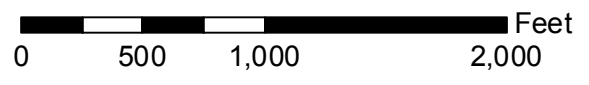
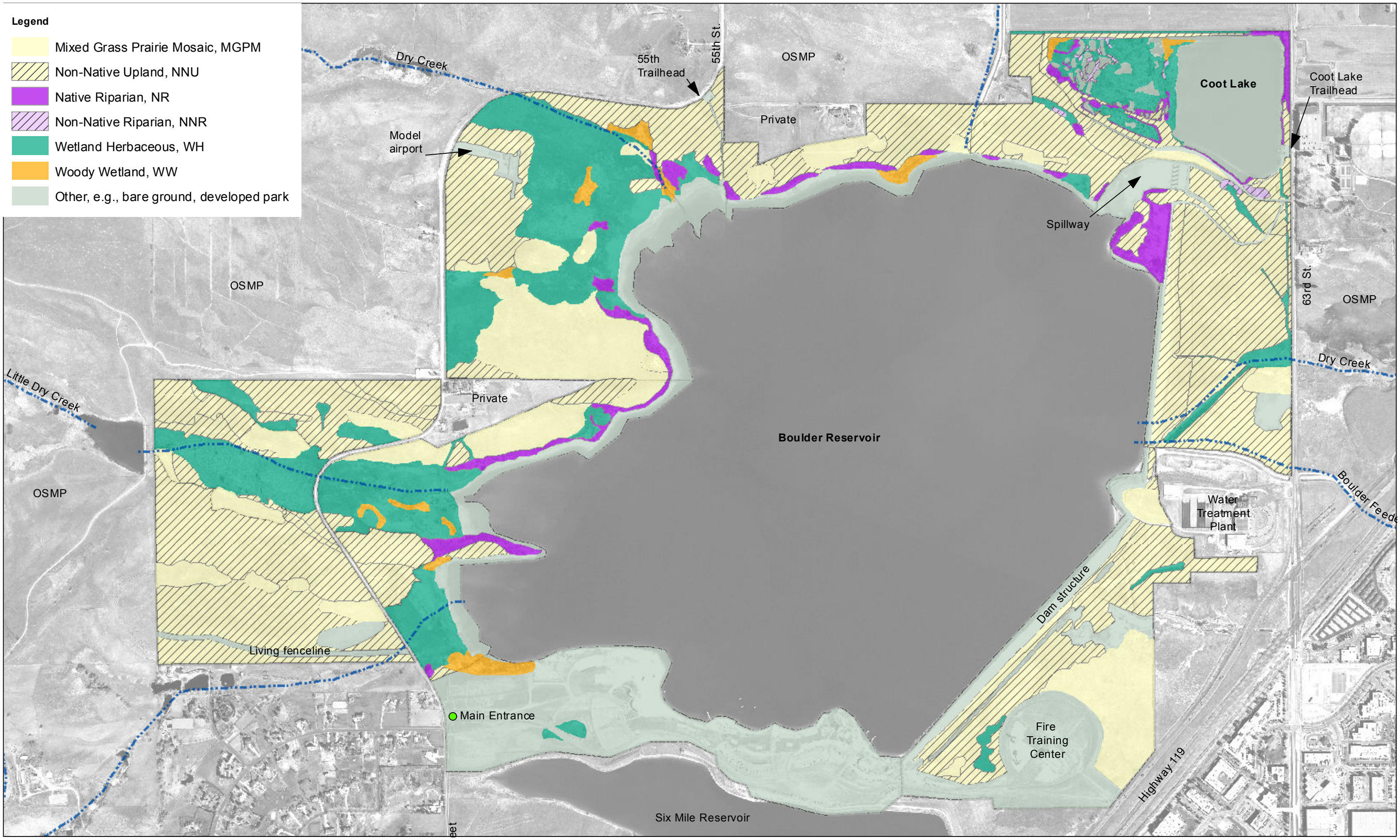
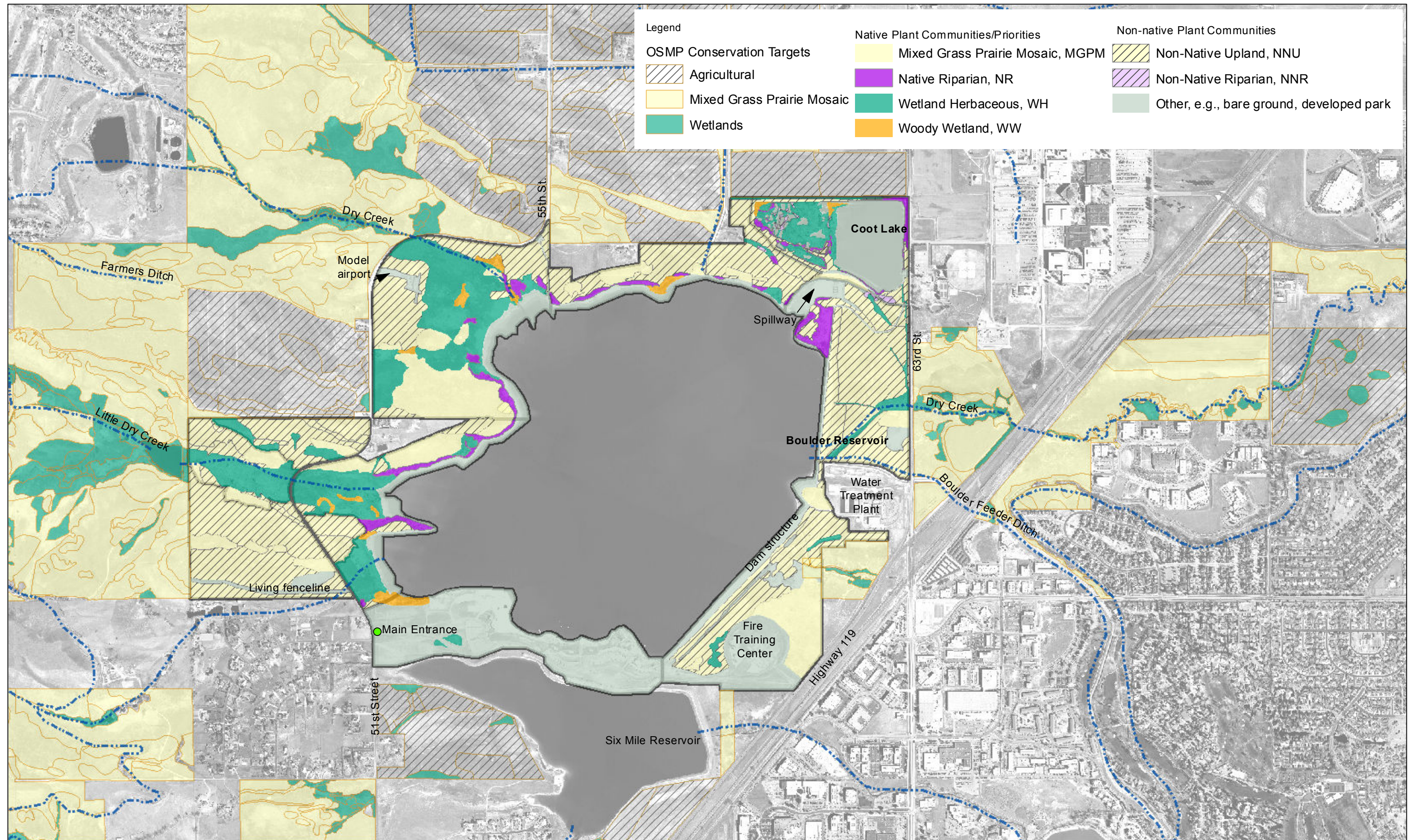


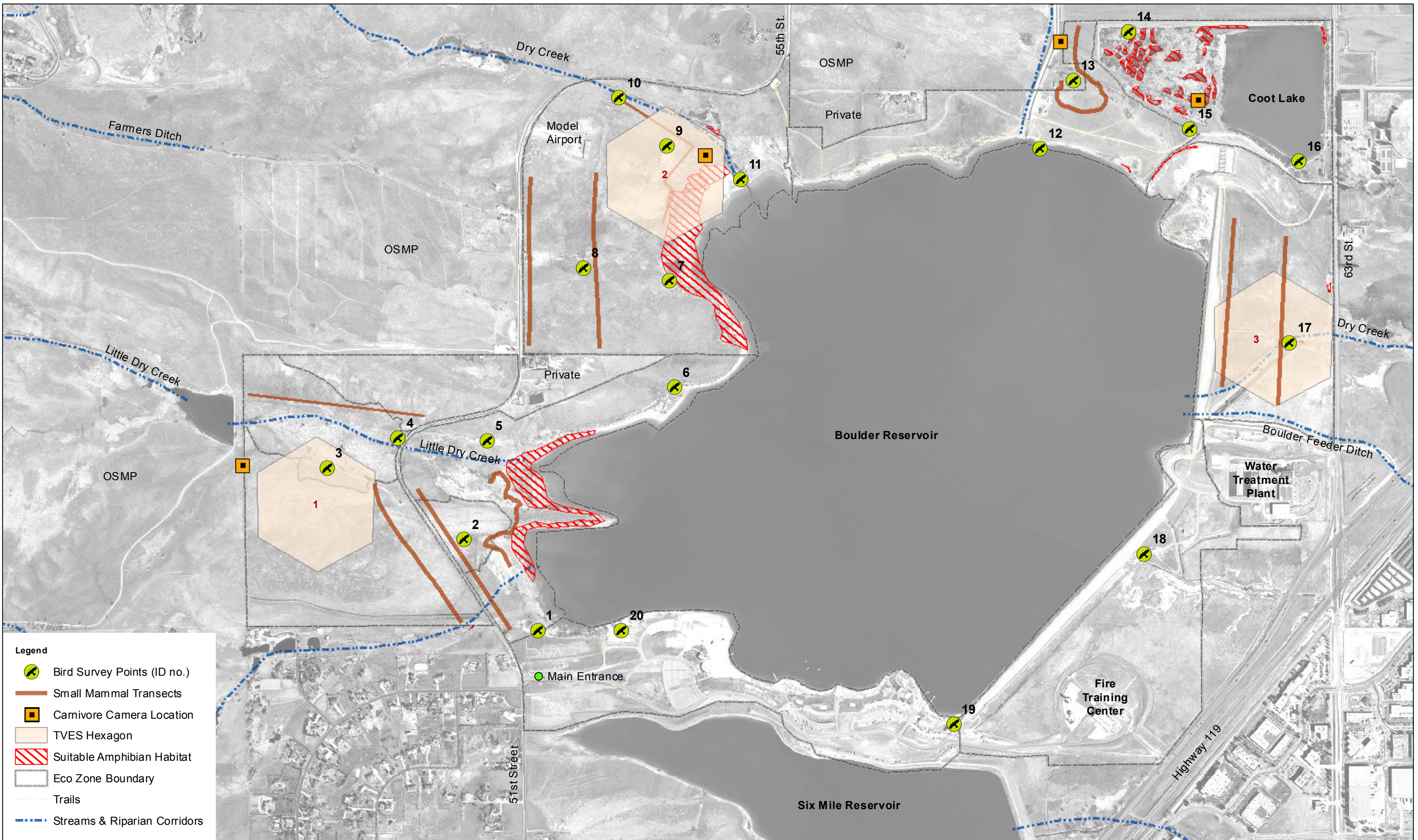
FIGURE 8
PLANT COMMUNITIES OF THE PROPERTY
BOULDER RESERVOIR



0 1,000 2,000 4,000 Feet



FIGURE 9
CONNECTIVITY OF PLANT COMMUNITIES
WITH NEIGHBORING CONSERVATION TARGETS



Note: See Appendix for PrairieDog Survey data collected by City staff.

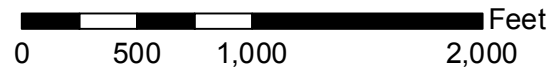
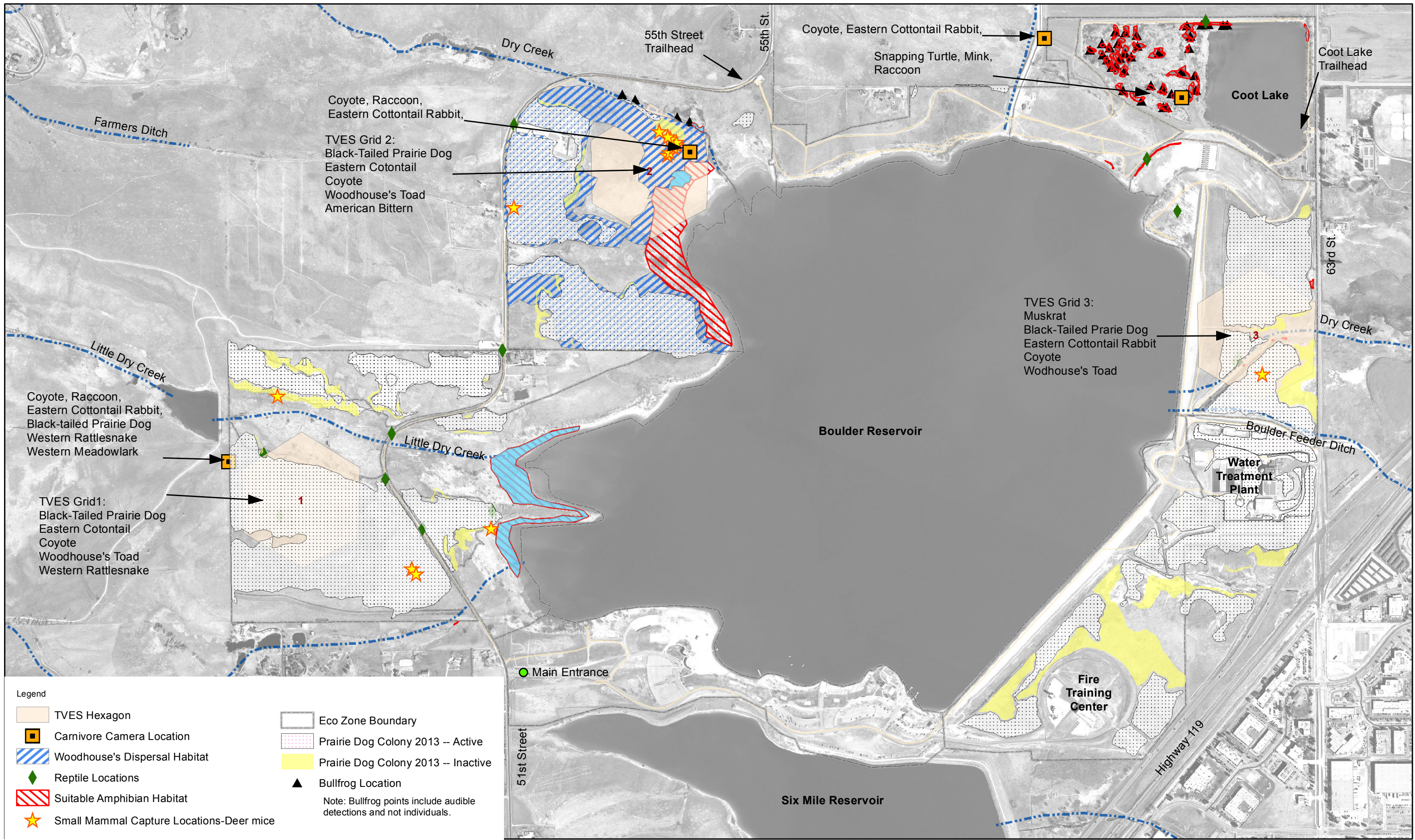


FIGURE 10
WILDLIFE SURVEY LOCATIONS
BOULDER RESERVOIR



Note: Refer to Appendix C for Bird Survey result figures. Prairie Dog mapping provided by City of Boulder Parks and Recreation Department.

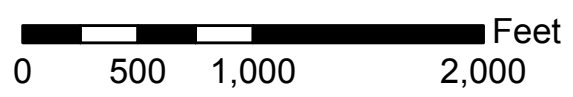


FIGURE 11
WILDLIFE SURVEY OBSERVATIONS
BOULDER RESERVOIR

APPENDIX A
ADDITIONAL BOULDER RESERVOIR VEGETATION INFORMATION

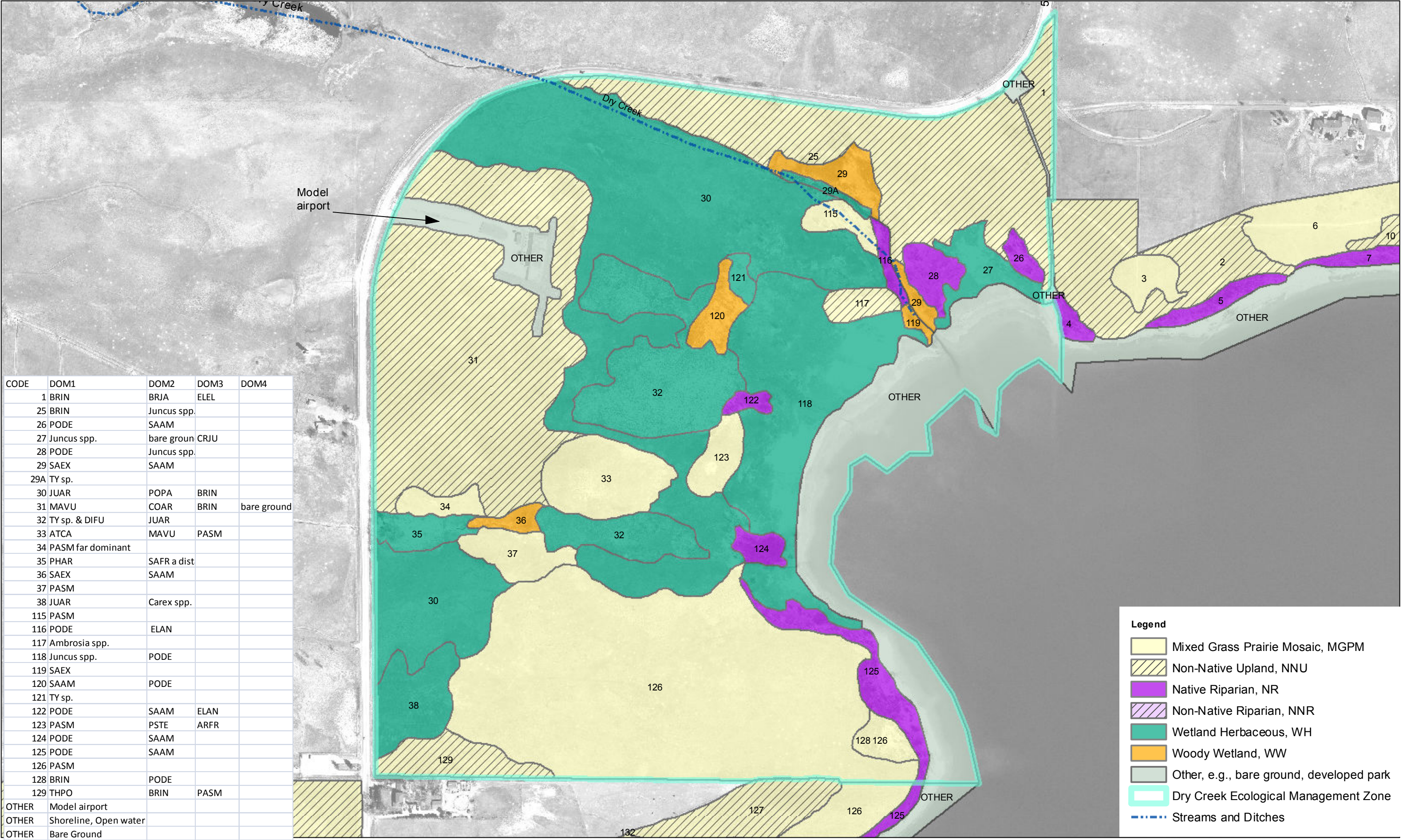


FIGURE A1
DRY CREEK DETAILED VEGETATION MAP
BOULDER RESERVOIR

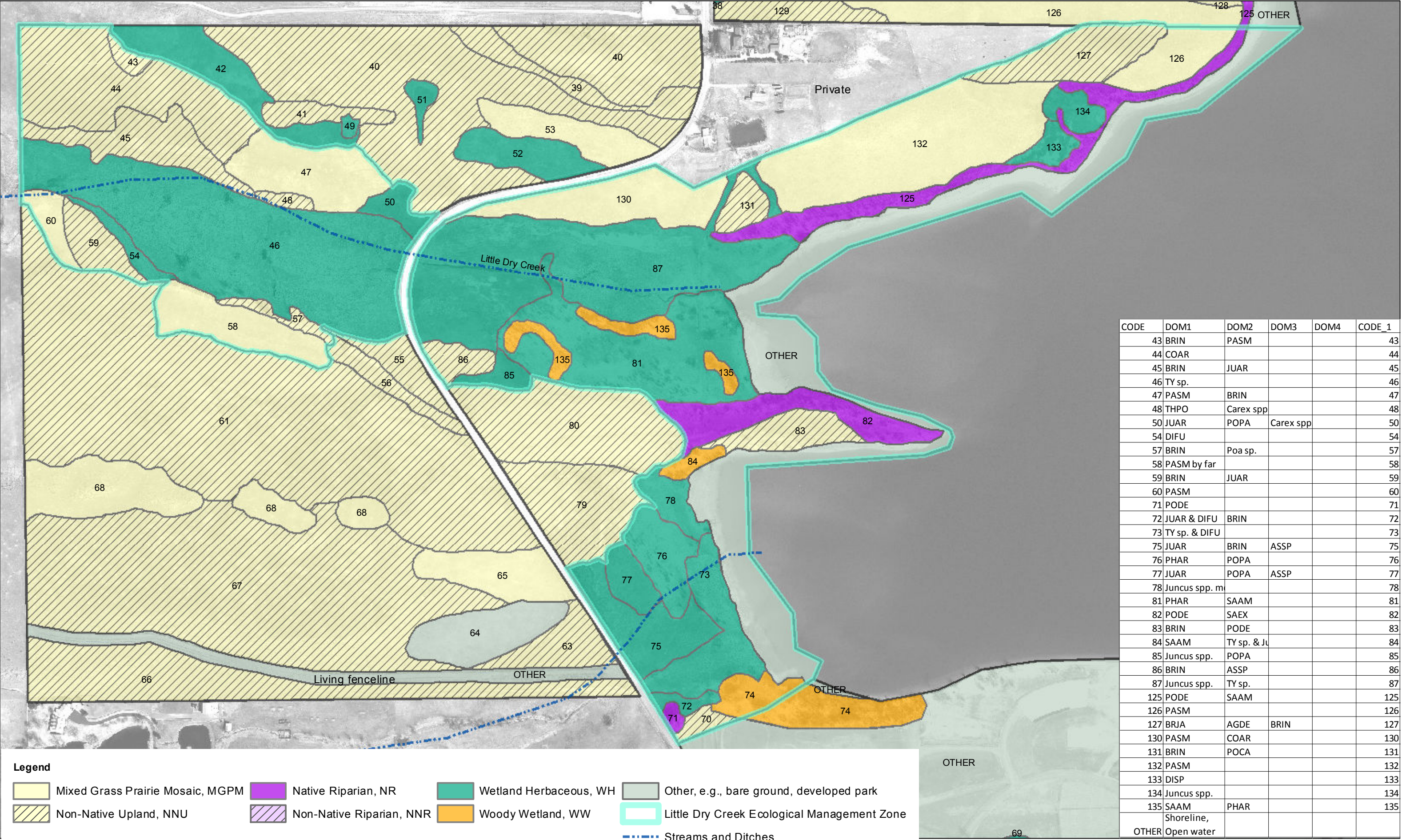


FIGURE
A2 LITTLE DRY CREEK DETAILED VEGETATION MAP
BOULDER RESERVOIR

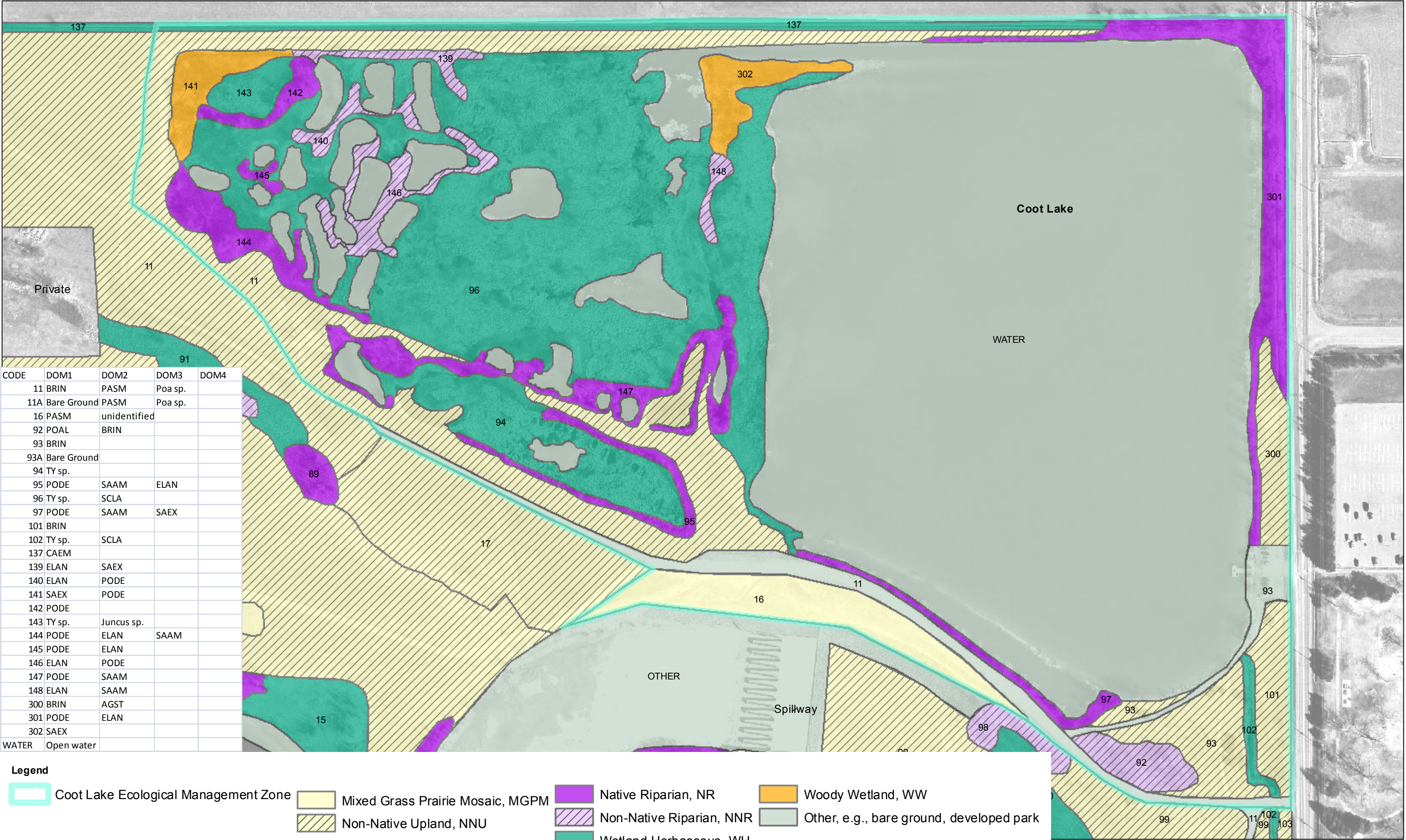


FIGURE A3
COOT LAKE DETAILED VEGETATION MAP
BOULDER RESERVOIR

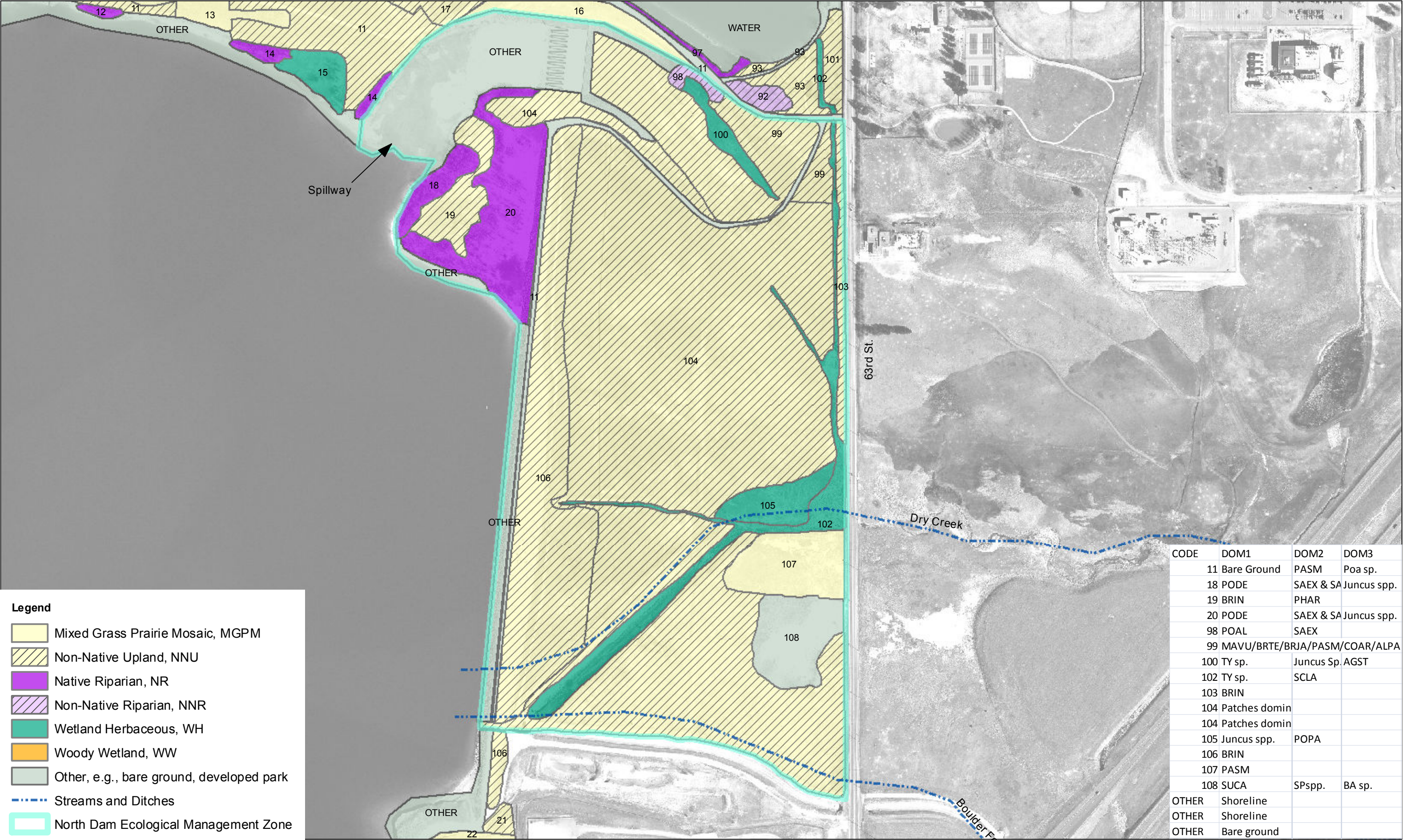


FIGURE A4
NORTH DAM DETAILED VEGETATION MAP
BOULDER RESERVOIR

CODE	DOM1	DOM2	DOM3
21	AGDE	PASM	
22	ANTE & HECO & PASM & ARPU		
23	DIFU	RUCR	ASSP
24	PASM w/ lg patches of COAR	BRJA	ANTE
106	BRIN		
109	JUAR	DIFU	
110	COAR w/ lg patches of PASM	BRIN	Alyssum
111	PASM	COVA	SYAL
112	Living fence		
113	Living fence		
114	BRIN		
136	Salt Flat		
OTHER	Shoreline		
OTHER	Fire Training Center, ROW		



0 250 500 1,000 Feet



FIGURE A5
SOUTH DAM DETAILED VEGETATION MAP
BOULDER RESERVOIR

CODE	DOM1	DOM2	DOM3
2	BRIN		
3	PASM	CHGR	
4	PODE	BRIN	
5	PODE	BRIN	
6	PASM	GUSA	PSTE
7	PODE	BRIN	
8	SAEX	SAAM	
9	PODE	BRIN	
10	BRIN	MAVU	BRJA
11	BRIN	PASM	Poa sp.
11	BRIN	PASM	Poa sp.
12	PODE		
13	PASM	HECO	
14	PODE		
14	PODE		
15	Juncus sp.	PODE	SAAM & TY
17	BRIN	Poa sp.	JUAR
88	PASM		
89	PODE	BRIN	
90	ELAN		
91	TY sp.		
137	CAEM		
OTHER	Shoreline		
OTHER	Bare Grou		

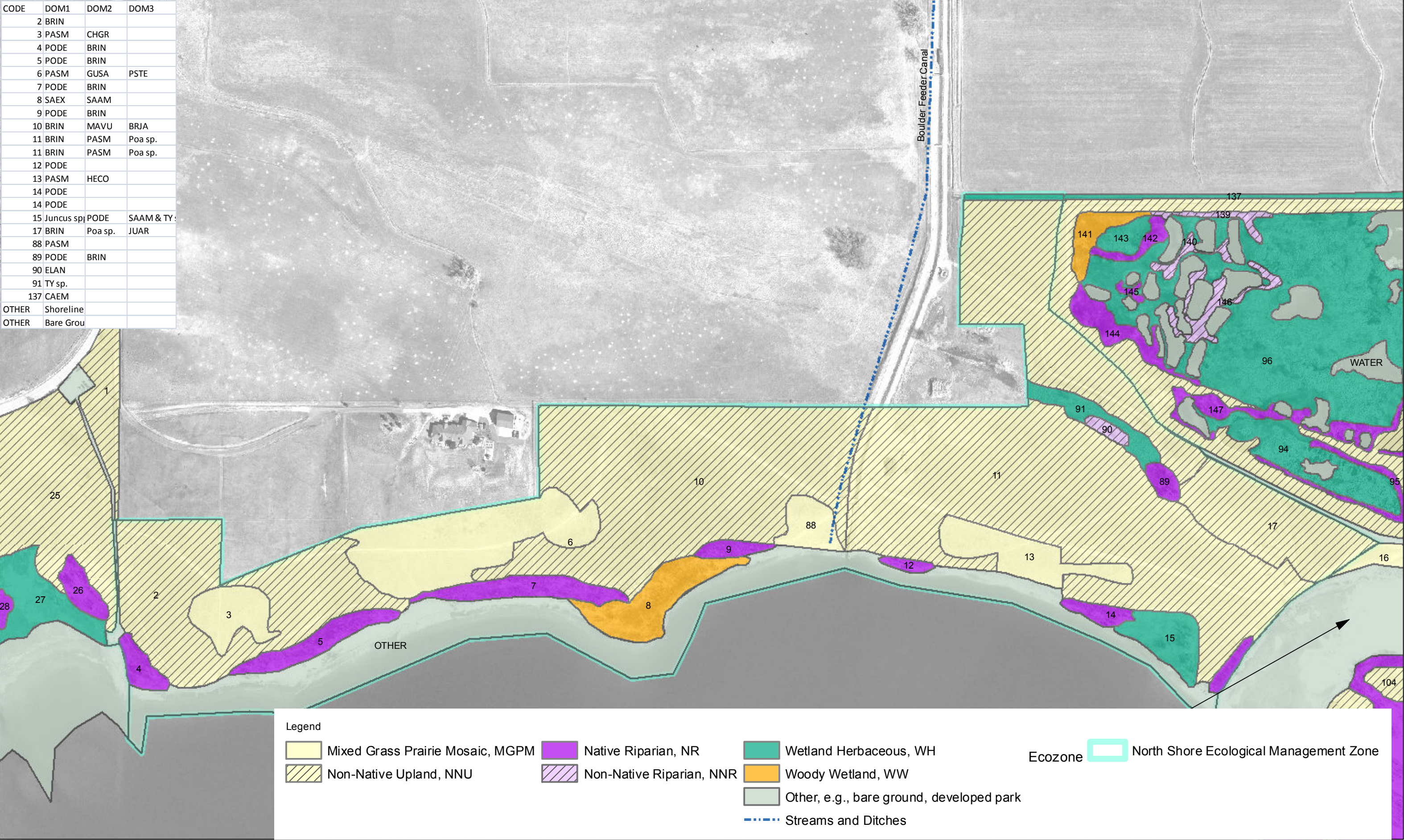
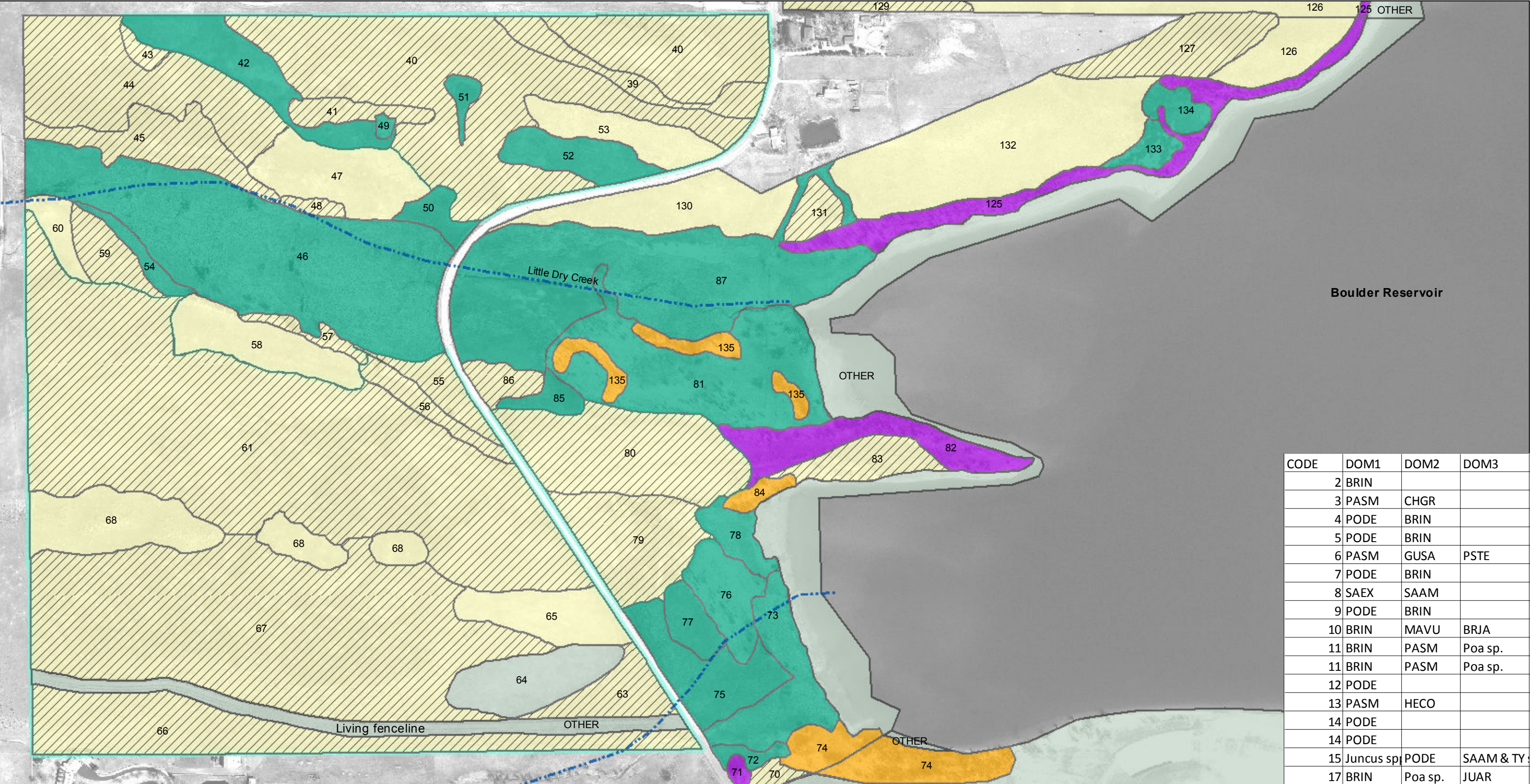


FIGURE A6
NORTH SHORE DETAILED VEGETATION MAP
BOULDER RESERVOIR



FIGURE A7
SOUTH SHORE DETAILED VEGETATION MAP
BOULDER RESERVOIR



Legend

- Mixed Grass Prairie Mosaic, MGPM

Non-Native Upland, NNU
- Native Riparian, NR

Non-Native Riparian, NNR
- Wetland Herbaceous, WH

Woody Wetland, WW

Other, e.g., bare ground, developed park

Streams and Ditches
- Western Uplands Ecological Management Zone

CODE	DOM1	DOM2	DOM3
2	BRIN		
3	PASM	CHGR	
4	PODE	BRIN	
5	PODE	BRIN	
6	PASM	GUSA	PSTE
7	PODE	BRIN	
8	SAEX	SAAM	
9	PODE	BRIN	
10	BRIN	MAVU	BRJA
11	BRIN	PASM	Poa sp.
11	BRIN	PASM	Poa sp.
12	PODE		
13	PASM	HECO	
14	PODE		
14	PODE		
15	Juncus sp.	PODE	SAAM & TY
17	BRIN	Poa sp.	JUAR
88	PASM		
89	PODE	BRIN	
90	ELAN		
91	TY sp.		
137	CAEM		
OTHER	Shoreline		
OTHER	Bare Grou		

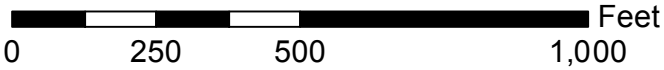


FIGURE A8
WESTERN UPLANDS DETAILED VEGETATION MAP
BOULDER RESERVOIR

APPENDIX B
ADDITIONAL WILDLIFE SURVEY INFORMATION

Appendix B -- Wildlife Survey Methods

1. Literature Review

Prior to conducting field surveys, the U.S. Fish and Wildlife Service (USFWS) current list of federally protected species for Boulder County and the Colorado Division of Parks and Wildlife (CPW) list of state sensitive species was reviewed to determine if any of these species potentially occurred within the study area. Sources of information used to identify sensitive wildlife species habitat types and affinities included Amphibians and Reptiles in Colorado (Hammerson, 1999), Mammals of Colorado (Armstrong et al., 2011), the Colorado Division of Parks and Wildlife (CPW) website (CPW, 2013), and NatureServe Explorer (NatureServe, 2013).

1.2 Federally Listed Species

No habitat for federally protected species is present within the study area. No designated critical habitat exists for any listed species within the study area.

1.3 Baseline Surveys

A variety of wildlife baseline surveys were conducted for the purpose of establishing a baseline index of species currently living within the study area. Survey techniques included Terrestrial Visual Encounter Surveys (TVES) to identify rare, elusive, or hard to detect species; nocturnal and diurnal amphibian surveys using calls and visual identification; scent stations with infrared cameras to detect nocturnal rare carnivores and other species; small mammal trapping; and pedestrian surveys of the parcels to specifically look for wildlife and sign which may not have been detected using other survey techniques. At all times while conducting the surveys, the biologist used A Field Guide to Mammal Tracking in North America (Halfpenny 1986) and Animal Tracks (Murie, 1954) to aid in species identification. These different survey techniques and the results of the surveys are presented in the following Sections 3.2.1 through 3.2.5.

1.3.1 General Wildlife Surveys

General wildlife surveys were conducted throughout the study area, concurrent with other surveys, as appropriate. These surveys included site-wide observations for mammals (predator and prey species) and amphibians and reptiles in appropriate habitats. In addition, the biologist looked for the presence of any Special Status wildlife species at all times. All wildlife observations were identified to species. Habitat associations for wildlife are matched to the vegetation sampling mapping.

General wildlife surveys were conducted using TVES arranged according to the USFS Multiple Species Inventory and Monitoring (MSIM) (Manley et al., 2006) grid system within representative areas of each habitat type present. Pedestrian surveys were conducted throughout the study area. Most of the study area was walked on multiple occasions for the purpose of identifying wildlife or wildlife sign (i.e., tracks, scat, etc.). Additionally, biologists documented all wildlife species and sign encountered while conducting the surveys. A complete species list for all species observed during the 2013 surveys is provided in Table B1.

1.3.2 Targeted Wildlife Surveys

In addition to General Wildlife Surveys, Targeted Wildlife Surveys were conducted. Targeted surveys included carnivore camera scent stations, diurnal and nocturnal amphibian/reptile surveys, and small mammal trapping surveys.

1.3.2.1 Survey Methods

General Wildlife Surveys: TVES - The survey grid is a hexagon with survey points evenly distributed and separated by 200 m (Figure 2). TVES is an effective passive sampling technique for detecting nocturnal and diurnal raptors and general wildlife. The technique is simple and effective, and useful for a wide variety of species (Heyer et al., 1994; Wemmer et al., 1996) that may be missed by the other core methods (small mammal trapping and camera surveys), such as some ungulates, lagomorphs and raptors (Forys and Humphrey, 1997; Weckerly and Ricca, 2000).

TVES surveys were conducted twice at each of three locations (Figure 10) numbered 1–3 from west to east; transects within the TVES grid were oriented west to east. TVES grid No.1 was surveyed June 18 and July 2; No. 2 on June 20 and July 4; No. 3 June 24 and July 5, 2013. Surveys were conducted in the morning between 0006 and 0090 hours or in the evening between 1900 and 2130 hours. GPS coordinates and a photo were recorded in each cardinal direction from the center point of each TVES grid to aid in relocation and to establish a photographic baseline of each grid.

The biologist systematically surveyed for individual animals and animal sign by traversing the sampling hexagon along transects spaced at 50 m intervals that looped through the hexagon. All areas within 1 meter of the transect line were surveyed; at times the surveyor deviated from the survey route to examine an item further off the survey line. The identification of wildlife sign (i.e., scat, tracks, scratching, etc.) was assisted in the field by referencing both A Field Guide to Mammal Tracking in North America (Halfpenny 1986) and Animal Tracks (Murie, 1954). The first time each TVES grid was surveyed the surveyor started surveying to the east, the second time to the west. This insured that all areas along the edge of the grid were examined at least once and each main transect was surveyed from two different directions. Each TVES transect surveyed equals approximately 8,530 feet (2,600 m) in length.

Targeted Wildlife Surveys: Carnivore Camera Scent Stations- Infrared cameras and associated scent stations were placed at three locations to assist in the detection of uncommon and nocturnal mammals. Camera locations (Figure 10) were agreed upon by the team and were intended to be near natural movement corridors where wildlife detection opportunities would be greatest. The cameras stations were as follows: on the western property boundary west of Coot Lake (No. 1); in the northwest corner of the study area near the reservoir and south of Dry Creek (No. 2); the extreme west boundary of the study area south of Little Dry Creek (No. 3); and within the Coot Lake wetlands (No. 4). At each location an infrared trail camera was used to document species encounters. A Bushnell® Trophy Cam trail camera was set up to capture color photos during the day and black and white photos at night. Infrared LED night vision flash was used so that a visible flash would not scare wildlife or disclose the location of the cameras to humans. Caven's Gusto (Schmitt Enterprises Inc.) scent, a skunk-based lure, was used to attract wildlife to the camera stations. This lure is made to attract most carnivores, including coyotes (*Canis latrans*), red fox (*Vulpes vulpes*) and bobcat (*Lynx rufus*). The camera was placed at station No. 1 on June 17, moved to station No. 2 on June 24, and moved to station No. 3 on July 3 where it remained until July 11, 2013, on August 5th station No. 4 was added (after consultation with the City) where the camera remained until August 19.

Deer Mouse being released.



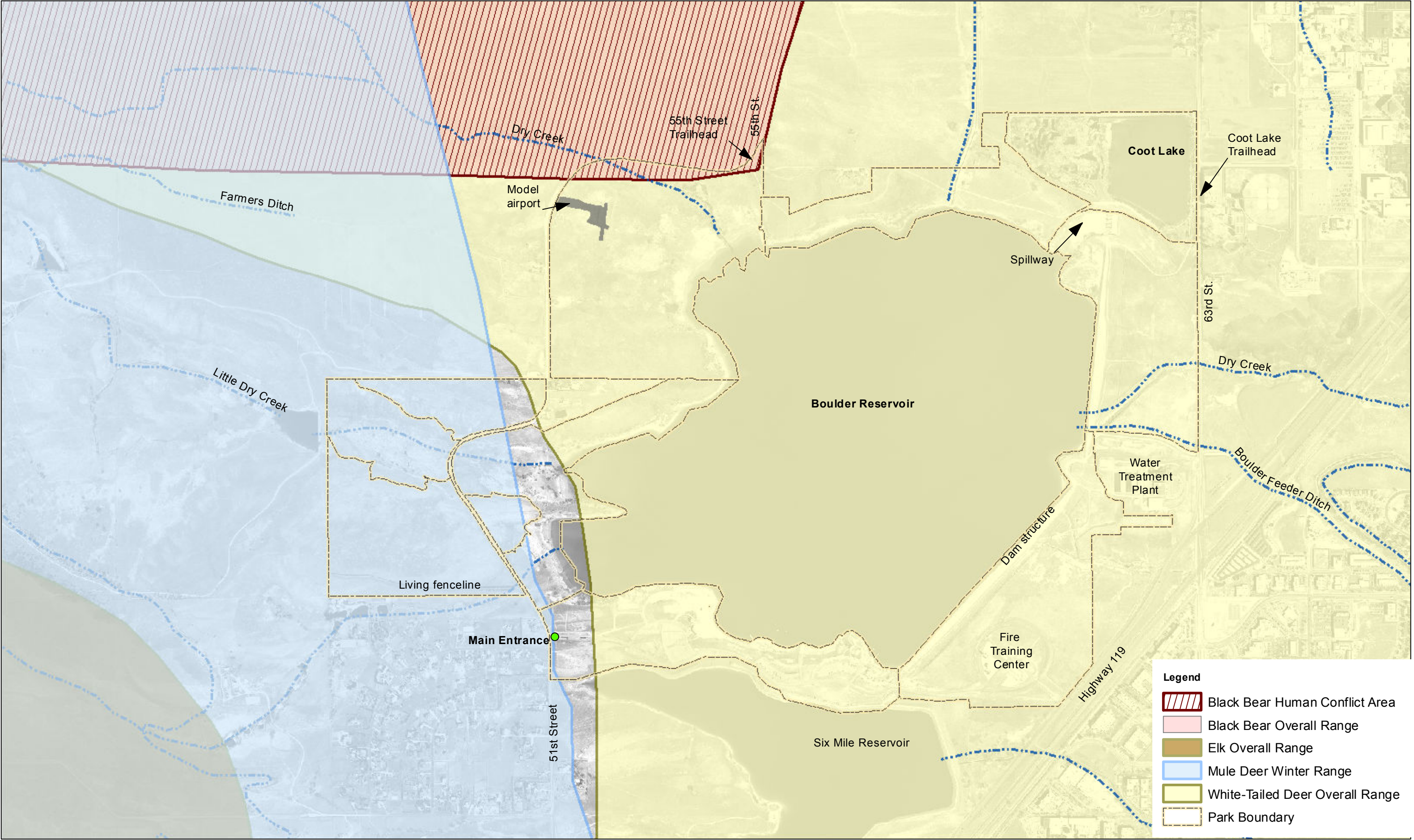
Targeted Wildlife Surveys: Amphibians and Reptiles - Amphibian call surveys occurred on the nights of June 18, 19, 20 and July 2, 2013. Areas surveyed were determined by first visiting potential habitat during the day and searching these areas for adults, juveniles, or eggs. When approaching the area to be surveyed the surveyor would stop and listen at distance of approximately 50 m before moving forward. If there was active calling occurring when the surveyor arrived at the location the surveyor would listen to determine which species were present. Species were documented based on visual identification or call. At all times that the surveyor was in the field the surveyor would look for amphibians/reptiles, including searching under logs, boards, etc. that were found in the study area.

Targeted Wildlife Surveys: Small Mammal Trapping - To assess impacts to wildlife associated with recreation we established three sets of paired transects (established in GIS using vegetation type data collected in 2013) of 50 Sherman small mammal live traps. Traps were set approximately every 10 meters along each transect and each trap was placed for one night for a total of 50 trap-nights per transect (1 trap out for 1 night equals 1 trap-night). Two other non-paired transects were established in areas of interest to City of Boulder personnel; traps were set as for the paired transects and all transects combined for a total of 400 trap nights. Two additional transects were established in which the traps remained at the same location for two nights - adding 200 trap nights for a grand total of 600 trap nights. Traps were set in the evening after 1900 hours, baited with sweetened oats and corn (omolene), synthetic batting was added to each trap to protect captured small mammals from cold stress, and traps were checked and recovered in the morning between 0600 and 0800 hours. Any trap in which a capture occurred was washed with a bleach solution to prevent disease exposure to other small mammals and the surveyor.

Table B1. 2013 Boulder Reservoir Biological Surveys Wildlife Species List

Scientific Name *	Common Name	Detection Method
Avian		
<i>Pelecanus erythrorhynchos</i>	American White Pelican	Visual
<i>Branta canadensis</i>	Canada Goose	Visual
<i>Anas platyrhynchos</i>	Mallard	Visual
<i>Cathartes aura</i>	Turkey Vulture	Visual
<i>Buteo jamaicensis</i>	Red-tailed Hawk	Visual
<i>Pandion haliaetus</i>	Osprey	Visual
<i>Falco sparverius</i>	American Kestrel	Visual
<i>Ardea herodias</i>	Great Blue Heron	Visual
<i>Botaurus lentiginosus</i>	American Bittern	Visual
<i>Rallus limicola</i>	Virginia Rail	Aural
<i>Charadrius vociferus</i>	Killdeer	Visual
<i>Gallinago gallinago</i>	Common Snipe	Aural
<i>Zenaida macroura</i>	Mourning Dove	Visual
<i>Streptopelia decaocto</i>	Eurasian Collared Dove	Visual
<i>Bubo virginianus</i>	Great Horned Owl	Visual
<i>Chordeiles minor</i>	Common Nighthawk	Visual
<i>Colaptes auratus</i>	Northern Flicker	Visual
<i>Tyrannus tyrannus</i>	Eastern Kingbird	Visual
<i>Tyrannus verticalis</i>	Western Kingbird	Visual
<i>Eremophila alpestris</i>	Horned Lark	Visual
<i>Hirundo pyrrhonota</i>	Cliff Swallow	Visual
<i>Pica pica</i>	Black-billed Magpie	Visual
<i>Corvus corax</i>	Common Raven	Visual
<i>Turdus migratorius</i>	American Robin	Visual
<i>Sturnus vulgaris</i>	European Starling	Visual
<i>Setophaga petechia</i>	Yellow Warbler	Visual
<i>Geothlypis trichas</i>	Common Yellowthroat	Visual
<i>Sturnella neglecta</i>	Western Meadowlark	Visual
<i>Agelaius phoeniceus</i>	Red-winged Blackbird	Visual
<i>Quiscalus quiscula</i>	Common Grackle	Visual
<i>Molothrus ater</i>	Brown-headed Cowbird	Visual
<i>Icterus bullockii</i>	Bullock's Oriole	Visual
<i>Guiraca caerulea</i>	Blue Grosbeak	Visual
<i>Carpodacus mexicanus</i>	House Finch	Visual
<i>Carduelis tristis</i>	American Goldfinch	Visual
<i>Spiza americana</i>	Dickcissel	Visual
<i>Pooecetes gramineus</i>	Vesper Sparrow	Visual
<i>Chondestes grammacus</i>	Lark Sparrow	Visual
<i>Melospiza melodia</i>	Song Sparrow	Visual
Mammals		
<i>Cynomys ludovicianus</i>	Black-tailed Prairie Dog	Visual
<i>Ondatra zibethicus</i>	Muskrat	Visual
<i>Peromyscus maniculatus</i>	Deer Mouse	Visual
<i>Sylvilagus floridanus</i>	Eastern Cottontail Rabbit	Visual
<i>Canis latrans</i>	Coyote	Visual

Table B1. 2013 Boulder Reservoir Biological Surveys Wildlife Species List		
Scientific Name *	Common Name	Detection Method
<i>Mustela erminea</i>	Ermine (Short-tailed Weasel)	Scat
<i>Procyon lotor</i>	Raccoon	Photographs/Tracks
Amphibians		
<i>Bufo woodhousii</i>	Woodhouse's Toad	Visual
<i>Pseudacris triseriata</i>	Western Chorus Frog	Aural
<i>Rana catesbeiana</i>	Bullfrog	Aural
Reptiles		
<i>Trionyx spiniferus</i>	Spiny Softshell	Visual
<i>Coluber constrictor</i>	Racer	Visual
<i>Thamnophis elegans</i>	Western Terrestrial Garter Snake	Visual
<i>Crotalus viridis</i>	Western Rattlesnake	Visual
* Species listed phylogenetically.		



The entire property is within the overall ranges for mule deer, mountain lion, and potential Preble's Meadow Jumping Mouse.

Source: This is a layer package created by the Colorado Parks and Wildlife GIS Unit in 2012 for distributing Colorado wildlife GIS data in a File Geodatabase (9.3.1 and 10.0 compatible) format for public distribution. This file was updated in October 2012

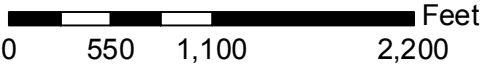


FIGURE B1
RANGES FOR SELECT WILDLIFE SPECIES-- MAMMALS
BOULDER RESERVOIR

APPENDIX C
2013 BREEDING AND MIGRATORY BIRD STUDY

Boulder Reservoir 2013 Breeding and Migratory Bird Study for Boulder Parks and Recreation Department



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Abstract

With the help of more than 20 Boulder Parks and Recreation staff and volunteers, I completed an April-July comprehensive breeding and migratory bird inventory at Boulder Reservoir and on Boulder Parks and Recreation lands surrounding the reservoir. During more than 55 hours of fieldwork, we observed a total of 114 bird species, of which 82 are potential nesters within the study area and 29 were confirmed nesting. Since 1995, various observers have reported at least 224 bird species at and within 1 km of Boulder Reservoir.

The wetlands on the west side of the reservoir and west of Coot Lake support unusually high concentration of Boulder County nesting birds of special concern, including American Bittern (isolated and restricted), Osprey (isolated and restricted), and Northern Harrier (rare and declining). These wetlands contain roughly half of all American bittern nesting territories documented in Boulder County since 1980. They support the only recently successful Northern Harrier nesting sites in Boulder County. They also support three Osprey nests, which have fledged 33 young since 2004.

Other Boulder County birds of special concern that have nested or may nest at the reservoir include Long-billed Curlew, Burrowing Owl, Loggerhead Shrike, Grasshopper Sparrow, and Bobolink. Colorado Natural Heritage Program tracked species observed at the reservoir during 2013 were American White Pelican, White-faced Ibis, Bald Eagle, Long-billed Curlew, Forster's Tern, and Bobolink.

The mosaic of cattail marshes, sedge/rush meadows, willow thickets, cottonwood groves, and mud flats surrounding the Dry Creek inlet at the northwestern corner of the reservoir nourishes several dozen species of migrating and nesting ducks, herons, and shorebirds. During May and June surveys, we observed Wood Ducks, Gadwalls, American Wigeons, Blue-winged Teal, Cinnamon Teal, Northern Shovelers, Northern Pintails, Green-winged Teal, Double-crested Cormorants, American White Pelicans, Great Egrets, Semipalmated Plovers, American Avocets, and a variety of other ducks and shorebirds foraging in this inlet. Cattail marshes in the Little Dry Creek drainage immediately west of the reservoir supported only small and isolated numbers of ducks, herons, and shorebirds. Excessive crowding of cattails in this area may inhibit nesting and foraging opportunities for these marsh-dependent species.

Areas of steeper shoreline along the west and north shore of the reservoir supported low numbers of migratory and nesting birds. In these areas, the "bathtub ring" effect--whereby large areas of bare lakeshore remain exposed in early spring--creates an inhospitable barrier between the reservoir surface and sheltering shoreline vegetation, precluding successful nesting by most ducks and shorebirds.

Though we observed a number of grassland-nesting bird species around the reservoir, nesting populations appear to be low compared to grassland-nesting bird populations in more natural prairies east of Boulder County. Most grasslands at Boulder Reservoir are in poor condition and dominated by non-native grasses and forbs. Restoration of these grasslands to a more natural condition would benefit a variety of prairie-nesting birds that once thrived on the plains of Boulder County, including Northern Harrier, Long-billed Curlew, Horned Lark, Lark Sparrow, Vesper Sparrow, and Grasshopper Sparrow.

Management strategies that enhance the diversity and extent of wetlands on the west side of the reservoir, protect these and other wetlands from incursions by recreational users and their pets, and restore native grasslands will benefit native bird populations at Boulder Reservoir. A major management challenge is protecting migratory nesting bird habitat from disturbance by the tens of thousands of recreationists who visit Boulder reservoir each year. Stronger enforcement of area closures, along with continued public education and outreach, will be necessary to sustain these vital habitats.

Introduction

With the assistance of Boulder Parks and Recreation staff and volunteers, I completed a breeding and migratory bird survey on Boulder Parks and Recreation lands surrounding Boulder Reservoir and Coot Lake during April-July 2013. The goals of the survey were:

1. Generate a comprehensive list of potential breeding and migratory birds within the study area. Identify habitats used for nesting or foraging by individual species.
2. Using distance sampling, develop estimates of absolute densities of individual species throughout the study area.
3. Document and map nesting and concentration areas for raptors, waterfowl, waders, shorebirds, and Federal, State, Colorado Natural Heritage Program, and Boulder County species of special concern.
4. Develop recommendations for preserving, enhancing, and protecting breeding and migratory bird habitat.

Study Area

Boulder Reservoir is a 285 ha multiuse recreational and water storage facility owned and managed by the City of Boulder and operated as a water supply by the Northern Colorado Water Conservancy District (Figure 1; Boulder Parks and Recreation Department website). The reservoir lies in central Boulder County within Township T1N, Section 3. The reservoir is surrounded by approximately 300 ha of Boulder Parks and Recreation Department-managed lands, including wetlands, grasslands, and scattered riparian woodlands. Coot Lake and its adjacent wetlands, approximately 50 m northeast of the reservoir outlet, are also managed by the City of Boulder. Public access for hiking, running, dog-walking, birdwatching, and other recreational activities is provided on most of these properties. Wetland areas immediately west and northwest of the reservoir and immediately west of Coot Lake are closed to the public during April-August, when American Bitterns, Ospreys, Northern Harriers, and other marsh-nesting birds breed in these areas.

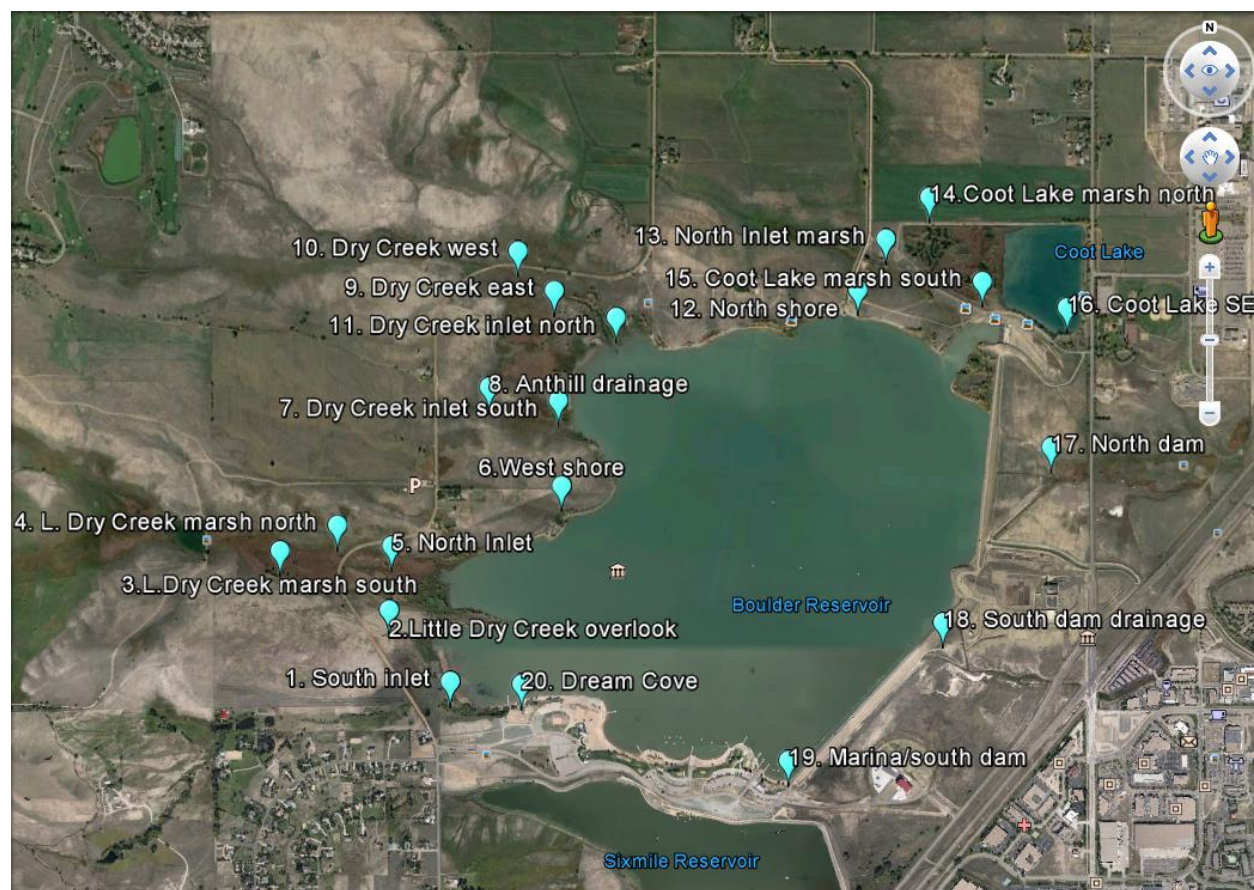
Vegetation within the public lands surrounding the reservoir includes cattail marshes, sedge/rush meadows; shortgrass prairie; mixed-grass prairie; riparian woodlands dominated by Plains Cottonwoods (*Populus deltoides*) and non-native willows; and shelter belts dominated by Rocky Mountain Juniper (*Sabina scopularum*) and introduced deciduous trees and shrubs (scientific names are from Weber 2012). Several prairie dog colonies exist in the Little Dry Creek and Dry Creek drainage west of the reservoir and below the reservoir dam. Grasslands throughout the City-managed lands surrounding the reservoir are dominated by non-native species, including Smooth Brome (*Bromopsis inermis*), Timothy (*Phleum pratense*), and Bindweed (*Convolvulus arvensis*).

The Little Dry Creek and Dry Creek drainages cut through the west side of the study area, forming extensive cattail marshes and sedge/rush meadows near their confluence with the reservoir. Another marsh area (about 10 ha in extent) lies just west of Coot Lake. Several unnamed ravines, some fed by

leakage and drainage from the reservoir dam and feeder canal, flow from and into the reservoir. These smaller drainages typically support small cattail marshes, along with scattered cottonwoods, Russian-Olives (*Elaeagnus Angustifolia*), and other deciduous trees.

Three private residences lie within the study area on the west and north sides of the reservoir. These properties support small groves of deciduous trees, along with small shelter belts containing Rocky Mountain Juniper (*Sabina scopularum*) and other non-native trees and shrubs.

Figure 1. Study area and point-count station locations.



Methods

During early April we established and mapped 20 point-count stations at least 250 m apart in diverse habitats around the reservoir and Coot Lake (Figure 1). We visited each point-count station once between 0430-0830 MST during 23-25 April, 13-15 May, 12-14 June, 27-29 June, and 11-13 July, counting all birds seen or heard perching or foraging within 200 m (12.56 ha plots) during 10 minutes. Birds flying through or over the plots were noted but not included in the population density analysis. We used a laser rangefinder to estimate the distance to each observed bird and used distance sampling software (Thomas et. al. 2010) to estimate the absolute density of the most abundant birds.

We used Colorado Breeding Bird Atlas II (2012) protocols to code breeding behaviors of all birds seen or heard. Birds seen or heard within suitable nesting habitat during their documented breeding season (Kingery 1998) were considered "potential nesting species." Birds exhibiting specific breeding behaviors (such as courtship, territorial defense, or territorial singing over a period of a week or more) within suitable nesting habitat were considered "probable nesting species," and birds observed in the act of nest building, incubation, brooding young, or feeding young--or with recently fledged young--were considered "confirmed nesting species."

We supplemented data from these surveys with observations by Boulder Parks and Recreation staff and field reports from 20 volunteers working on annual monitoring of birds of special concern at the reservoir (Jones 2006-13). We used records from the Boulder County Wildlife Inventory (1979-2013), eBird (1995-2013), previous monitoring studies (Jones 2006-13) and this study to compile a list of 224 bird species documented within the study area (Appendix III). We also used records from the Boulder County Monthly Wildlife Inventory to document presence of potential nesting species within the study area during five-year intervals from 1980-2013.

Results and Discussion

Between 10 April-31 July 2013 we observed 114 bird species within the study area, including 82 potential nesting species (birds seen or heard within suitable nesting habitat during their documented breeding season; Kingery 1998). This number of potential nesting species is comparable to numbers detected within protected lands surrounding other large reservoirs in eastern Colorado during recent studies using the same methodology.

Table 1. Potential nesting species documented in four reservoir parks in eastern Colorado.

Park	Observer Hours	Potential Nesting	CNHP Tracked Species ¹	Non-Native ²
Boulder Reservoir	55	82	6	5
John Martin Reservoir State Park ³	27	91	6	8
Lake Pueblo State Park ⁴	44	95	7	6
North Sterling Reservoir State Park ⁵	24	69	5	5

¹ Colorado Natural Heritage Program. 2012. Tracked bird species.

² Not documented nesting in Colorado prior to 1900 (Bailey 1902, Henderson 1908, Kingery 1998).

³ Jones 2013. ⁴ Jones 2011. ⁵ Jones 2008.

Potential nesting species observed during 2013 included 9 geese and ducks; 3 herons and ibis; 7 birds of prey; 2 rails; 5 shorebirds, 4 doves and owls, 2 woodpeckers, 4 flycatchers, 3 corvids, 4 swallows, 3 wrens and gnatcatchers, 3 thrushes, 2 warblers, 5 sparrows, 8 icterids, and 3 finches (Table 2).

Table 2. April-July 2013 observations.

Colorado Natural Heritage Program global ranking codes:

G3, vulnerable to extirpation or extinction; G4, widespread, abundant, and apparently secure;
G5, demonstrably widespread, abundant, and secure; T, rank applies to subspecies or variety.

Colorado Natural Heritage Program state ranking codes:

S1, state critically imperiled; S2, state imperiled; S3, state rare or uncommon; S4, state
apparently secure; B, breeding populations; N, non-breeding populations.

Boulder County Nature Association birds of special concern codes:

- 1: Rare and declining. Three or fewer annually documented nesting sites within the county.
- 3: Rare. Three or fewer annually documented nesting sites within the county.
- 4: Isolated and restricted (limited breeding habitat).
- 6: Extirpated as a locally breeding species.

Habitat abbreviations:¹

AEM: Emergent wetland	ASL: Shoreline	CPL: Croplands
CWD: Cultivated woodlands	LRD: Riparian woodland	MSB: Bridges
MSP: Poles	OWL: Open water	RRL: Rural residential
SLE: Shrublands	TMG: Mixed-grass prairie	TSG: Shortgrass prairie
TSU: Barren ground	UPK: City parks	

Species	Habitats	Breeding Behavior ²	CNHP Tracked ³	BCNA Concern ⁴
Canada Goose	AEM, ASL, OWL	Fledged young		
Wood Duck	AEM, OWL	Seen 28 June		
Gadwall	ASL, OWL	Pair		
American Wigeon	ASL, OWL	Pair		
Mallard	AEM, ASL, OWL	Fledged young		
Blue-winged Teal	ASL, OWL	Pair		
Cinnamon Teal	ASL, OWL	Seen 11 June		
Northern Shoveler	ASL, OWL	Seen 13 May, 11 June		
Northern Pintail	ASL, OWL	Observed non-breeder		
Green-winged Teal	ASL, OWL	Pair		
Redhead	ASL, OWL	Observed non-breeder		
Ring-necked Duck	OWL	Observed non-breeder		
Greater Scaup	OWL	Observed non-breeder		
Lesser Scaup	OWL	Observed non-breeder		
Common Merganser	OWL	Observed non-breeder		
Red-breasted Merganser	OWL	Observed non-breeder		
Northern Bobwhite	UPK	Seen 28 June		1
Pied-billed Grebe	AEM, OWL	Seen 5 May		
Eared Grebe	OWL	Observed non-breeder		1
Western Grebe	OWL	Observed non-breeder		
Clark's Grebe	OWL	Observed non-breeder		
Double-crested Cormorant	ASL, OWL	Observed non-breeder		

Species	Habitats	Breeding Behavior ²	CNHP Tracked ³	BCNA Concern ⁴
American White Pelican	ASL, OWL	Observed non-breeder	G3;S1B	
American Bittern	AEM	Territory		4
Great Blue Heron	ASL, LRD, OWL	Occupied nest		
Great Egret	ASL, OWL	Observed non-breeder		3, 4
Black-crowned Night Heron	ASL	Seen 5 May		
White-faced Ibis	ASL, AEM	Seen 13 May	G5;S2B	
Turkey Vulture	TMG	Observed non-breeder		
Osprey	MSP, ASL	Nest with young		
Bald Eagle	MSP, ASL	Observed non-breeder	G5;S1B,S3N	4
Northern Harrier	AEM	Pair		1, 4
Cooper's Hawk	LRD	Seen 22 April		
Swainson's Hawk	LRD	Pair		
Red-tailed Hawk	LRD	Nest with young		
Virginia Rail	AEM	Territory		
Sora	AEM	Territory		
American Coot	AEM	Territory		
Semipalmated Plover	ASL	Observed non-breeder		
Killdeer	ASL, AEM, TSU	Fledged young		
American Avocet	ASL, AEM	Pair		
Spotted Sandpiper	ASL	Feeding fledglings		
Lesser Yellowlegs	ASL	Observed non-breeder		
Long-billed Curlew	ASL, AEM	Seen 10 May	G5;S2B	6
Baird's Sandpiper	ASL	Observed non-breeder		
Wilson's Snipe	AEM	Fledged young		
Ring-billed Gull	ASL, OWL	Observed non-breeder		
Forster's Tern	OWL	Observed non-breeder	G5;S2B,S4N	
Rock Pigeon	MSP	Seen 11 June		
Eurasian Collared-Dove	LRD, RRL	Nest building		
Mourning Dove	LRD, RRL	Fledged young		
Great Horned Owl	RRL	Occupied nest		
Broad-tailed Hummingbird	AEM, LRD	Observed non-breeder		
Belted Kingfisher	ASL, AEM	Seen 11, 28 June		
Downy Woodpecker	LRD	Fledged young		
Northern Flicker	LRD	Fledged young		
American Kestrel	LRD	Territory		
Western Wood-Pewee	LRD	Singing male		
Say's Phoebe	TMG	Territory		
Western Kingbird	LRD, RRL	Nest with young		
Eastern Kingbird	LRD	Agitated behavior		
Loggerhead Shrike	TMG	Seen 25 April		1, 4
Warbling Vireo	LRD	Territory		
Blue Jay	UPK	Territory		
Black-billed Magpie	LRD, RRL	Fledged young		
American Crow	LRD, RRL	Fledged young		

Species	Habitats	Breeding Behavior ²	CNHP Tracked ³	BCNA Concern ⁴
Common Raven	LRD	Observed non-breeder		
Horned Lark	TSG	Seen 25 April		
Tree Swallow	AEM	Seen 11, 28 June		
Violet-green Swallow	AEM	Observed non-breeder		
Northern Rough-winged Swallow	AEM	Seen 25 April		
Cliff Swallow	AEM, ASL, TMG	Nest with young		
Barn Swallow	UPK, AEM	Occupied nest		
Black-capped Chickadee	LRD	Fledged young		
Mountain Chickadee	CWD	Observed non-breeder		
White-breasted Nuthatch	RRL	Seen 10 May		
House Wren	SLE	Territory		
Marsh Wren	AEM	Heard 2 June		
Blue-gray Gnatcatcher	CWD	Seen 13 May		
Mountain Bluebird	TMG	Seen 22 April		
American Robin	LRD, UPK	Carrying food		
Gray Catbird	SLE	Singing male		
European Starling	RRL, UPK, LRD	Carrying food		
Cedar Waxwing	LRD	Seen 3 June		
Orange-crowned Warbler	AEM, LRD	Observed non-breeder		
Common Yellowthroat	AEM	Territory		
Blackburnian Warbler	LRD	Observed non-breeder		
Yellow Warbler	LRD	Territory		
Yellow-rumped Warbler	LRD	Observed non-breeder		
Green-tailed Towhee	SLE	Pair		
Spotted Towhee	SLE	Seen 25 April		
Chipping Sparrow	LRD, TMG	Observed non-breeder		
Vesper Sparrow	TMG	Territory		
Lark Sparrow	TMG	Courtship		
Savannah Sparrow	CPL, AEM	Singing male		
Grasshopper Sparrow	TMG	Territory		4
Song Sparrow	AEM	Territory		
White-crowned Sparrow	AEM, LRD	Observed non-breeder		
Dark-eyed Junco	CWD	Observed non-breeder		
Blue Grosbeak	LRD	Fledged young		
Dickcissel	CPL, AEM	Territory		
Bobolink	CPL, AEM	Singing male	G5,S3B	4
Red-winged Blackbird	AEM, LRD	Feeding fledglings		
Western Meadowlark	TMG	Carrying food		
Yellow-headed Blackbird	AEM, ASL	Pair		
Brewer's Blackbird	LRD, UPK	Carrying food		
Common Grackle	LRD, UPK, RRL	Feeding fledglings		
Brown-headed Cowbird	LRD, UPK, RRL	Courtship		
Orchard Oriole	LRD	Singing male		
Bullock's Oriole	LRD	Nest with young		

Species	Habitats	Breeding Behavior ²	CNHP Tracked ³	BCNA Concern ⁴
House Finch	UPK, RRL	Fledged young		
Pine Siskin	CWD	Observed non-breeder		
Lesser Goldfinch	LRD	Seen 11 June		
American Goldfinch	LRD, UPK	Feeding fledglings		
House Sparrow	UPK	Seen 11 June		

¹ Habitat codes are from Kingery, H.E. 1998. Colorado breeding bird atlas.

² Species seen or heard within suitable nesting habitat during their documented breeding season are considered "possible breeders." Species exhibiting specific territorial behaviors are considered "probable" breeders. Species exhibiting nesting behaviors such as nest building, nest with eggs, or recently fledged young are considered "confirmed" breeders. "Observed non-breeders" include birds for which there is no suitable nesting habitat within the study area and conspicuous birds, such as Bald Eagle, for which there is no documentation of nesting within the study area (Kingery 1998).

³ Colorado Natural Heritage Program. 2012. Tracked bird species.

⁴ Hallock, D., and S.R. Jones. 2010. Boulder County avian species of special concern. Boulder County Nature Association, www.bcna.org. Also included in the Boulder County Comprehensive Plan.

Four additional potential nesting species (Burrowing Owl, Common Nighthawk, Red-headed Woodpecker, and Lark Bunting) were observed during surveys conducted by Boulder County Parks and Recreation volunteers monitoring birds of special concern from 2009-12 (Table 3). Of the 2009-13 total of 87 potential nesting species, 29 were confirmed nesting within the study area in 2013, and an additional 28 are probable breeders based on exhibited nesting behaviors (Tables 2 and 3).

Historic Changes in Nesting Bird Populations

Table 4 summarizes 1980-2013 observations of potential nesting species from Boulder County Wildlife Inventory area 22, which encompasses most of the study area, including all of Boulder Reservoir and lands east of North 51st Street, south of Monarch Road, west of North 63rd Street, and north of the Boulder-Longmont Diagonal Highway. Since there are no controls for observer effort in this inventory these observations are more suggestive of presence, rather than absence, of individual species. In other words, the absence of reports of a given species during a given five-year interval should not be interpreted as evidence that the species was not present. Moreover, since Boulder Parks and Recreation initiated their species of special concern monitoring program in wetlands surrounding the reservoir in 2004, numbers of reported observations to the wildlife inventory have no doubt increased.

Nevertheless, Boulder County Wildlife Inventory records to shed light on some changes in nesting bird populations at Boulder Reservoir. A total of 10 species which were not reported between 1980-99 reported during 2000-13: Wood Duck, Northern Bobwhite, Eurasian Collared-Dove, Red-headed Woodpecker, Blue Jay, Blue-gray Gnatcatcher, Gray Catbird, Cedar Waxwing, Dickcissel, and Orchard Oriole.

Table 3. 2009-13 potential breeding species observations.¹

Colorado Natural Heritage Program global ranking codes:

G3, vulnerable to extirpation or extinction; G4, widespread, abundant, and apparently secure;
G5, demonstrably widespread, abundant, and secure; T, rank applies to subspecies or variety.

State Ranking Codes:

S1, state critically imperiled; S2, state imperiled; S3, state rare or uncommon; S4, state apparently secure; B, breeding populations; N, non-breeding populations.

Boulder County Nature Association birds of special concern codes:

1: Rare and declining. Three or fewer annually documented nesting sites within the county.

3: Rare 4: Isolated and restricted (limited breeding habitat).

6: Extirpated as a locally breeding species.

Species	Years	Breeding Behavior ²	CNHP Tracked ³	BCNA Concern ⁴
Canada Goose	2009-13	Fledged young		
Wood Duck	2009, 13	Seen		
Gadwall	2012-13	Pair		
American Wigeon	2013	Pair		
Mallard	2009-13	Fledged young		
Blue-winged Teal	2009, 12, 13	Pair		
Cinnamon Teal	2012-13	Seen 11 June		
Northern Shoveler	2009, 13	Seen 13 may, 11 June		
Green-winged Teal	2013	Pair		
Northern Bobwhite	2013	Seen 28 June		1
Pied-billed Grebe	2009, 11, 13	Seen 5 May		
American Bittern	2009-13	Fledged young		4
Great Blue Heron	2009-13	Nest with young		
Black-crowned Night Heron	2009, 13	Seen 5 May		
White-faced Ibis	2012-13	Seen 13 May	G5;S2B	
Osprey	2009-13	Nest with young		
Northern Harrier	2009-11, 13	Nest with young		1, 4
Cooper's Hawk	2013	Seen 22 April		
Swainson's Hawk	2009-11, 13	Pair		
Red-tailed Hawk	2009-13	Nest with young		
Virginia Rail	2009, 12-13	Territory		
Sora	2009, 12-13	Territory		
American Coot	2009-11, 13	Territory		
Killdeer	2009-13	Fledged young		
American Avocet	2013	Pair		
Long-billed Curlew	2013	Seen 10 May	G5;S2B	6
Spotted Sandpiper	2009-13	Feeding fledglings		
Wilson's Snipe	2009-13	Fledged young		
Rock Pigeon	2009-13	Seen 11 June		
Eurasian Collared-Dove	2011-13	Nest building		

Species	Years	Breeding Behavior ²	CNHP Tracked ³	BCNA Concern ⁴
Eurasian Collared-Dove	2011-13	Nest building		
Mourning Dove	2009-13	Fledged young		
Great Horned Owl	2009-13	Nest with young		
Burrowing Owl	2011	Pair		
Common Nighthawk	2009, 11-12	Courtship		
Belted Kingfisher	2009, 11-13	Seen 11, 28 June		
Red-headed Woodpecker	2011	Seen 26 May		
Downy Woodpecker	2009, 11, 13	Fledged young		
Northern Flicker	2009, 11-13	Fledged young		
American Kestrel	2009-13	Territory		
Western Wood-Pewee	2009-13	Singing male		
Say's Phoebe	2011, 13	Territory		
Western Kingbird	2009-13	Nest with young		
Eastern Kingbird	2010-13	Agitated behavior		
Loggerhead Shrike	2013	Seen 25 April		1, 4
Warbling Vireo	2009, 12-13	Territory		
Blue Jay	2009, 11, 13	Territory		
Black-billed Magpie	2009-13	Fledged young		
American Crow	2009-13	Fledged young		
Horned Lark	2009-11, 13	Seen 25 April		
Tree Swallow	2010-13	Seen 11, 28 June		
N. Rough-winged Swallow	2009, 13	Seen 25 April		
Cliff Swallow	2011-13	Nest with young		
Barn Swallow	2009-13	Occupied nest		
Black-capped Chickadee	2009, 13	Fledged young		
White-breasted Nuthatch	2013	Seen 10 May		
House Wren	2009-10, 13	Territory		
Marsh Wren	2013	Heard 2 June		
Blue-gray Gnatcatcher	2013	Seen 13 May		
Mountain Bluebird	2013	Seen 22 April		
American Robin	2009-13	Carrying food		
Gray Catbird	2013	Singing male		
European Starling	2009-13	Carrying food		
Cedar Waxwing	2013	Seen 3 June		
Common Yellowthroat	2009-13	Territory		
Yellow Warbler	2009-13	Fledged young		
Green-tailed Towhee	2013	Pair		
Spotted Towhee	2013	Seen 25 April		
Vesper Sparrow	2009-10, 13	Territory		
Lark Sparrow	2012-13	Courtship		
Lark Bunting	2010-11	Seen 26 May, 16 June		1
Savannah Sparrow	2012-13	Singing male		
Grasshopper Sparrow	2009, 12-13	Territory		4
Song Sparrow	2009, 12-13	Territory		

Species	Years	Breeding Behavior ²	CNHP Tracked ³	BCNA Concern ⁴
Blue Grosbeak	2009, 11, 13	Fledged young		
Dickcissel	2012-13	Territory		
Bobolink	2011, 13	Singing male	G5,S3B	4
Red-winged Blackbird	2009-13	Nest with young		
Western Meadowlark	2009-13	Carrying food		
Yellow-headed Blackbird	2009-11, 13	Fledged young		
Brewer's Blackbird	2012-13	Carrying food		
Common Grackle	2009-13	Feeding fledglings		
Brown-headed Cowbird	2009-13	Courtship		
Orchard Oriole	2013	Singing male		
Bullock's Oriole	2009, 11-13	Nest with young		
House Finch	2009, 12-13	Fledged young		
Lesser Goldfinch	2013	Seen 11 June		
American Goldfinch	2009-13	Feeding fledglings		
House Sparrow	2009-11, 13	Seen 11 June		

¹ 2009-12 observations are from Jones, S.R. 2006-12. Boulder Reservoir species of special concern monitoring reports. Boulder Parks and Recreation Department, 3198 Broadway, Boulder CO 80304.

² Species seen or heard within suitable nesting habitat during their documented breeding season are considered "possible breeders." Species exhibiting territorial behaviors are considered "probable" breeders. Species exhibiting nesting behaviors such as nest building, nest with eggs, or recently fledged young are considered "confirmed" breeders. "Observed non-breeders" include birds for which there is no suitable nesting habitat within the study area and conspicuous birds, such as Bald Eagle, for which there is no documentation of nesting within the study area (Kingery 1998).

³ Colorado Natural Heritage Program. 2012. Tracked bird species.

⁴ Hallock, D., and S.R. Jones. 2010. Boulder County avian species of special concern. Boulder County Nature Association, www.bcna.org. Also included in the Boulder County Comprehensive Plan.

Table 4. Historical observations of potential nesting species at or within 1 km of Boulder Reservoir from Boulder County Audubon Society 1979-2013 monthly wildlife inventories.¹

X: Indicates that the species was reported during at least one month, April-August, during the indicated five-year period, within wildlife inventory area 22, which encompasses Boulder Reservoir and lands north from the reservoir to Monarch Road and south from the reservoir to Colorado State Highway 119.

Species	1980-4	1985-9	1990-4	1995-9	2000-4	2005-9	2010-3
Canada Goose	X	X	X	X	X	X	X
Wood Duck					X	X	X
Gadwall	X	X	X	X	X	X	X
American Wigeon	X	X	X	X	X	X	X
Mallard	X	X	X	X	X	X	X

Species	1980-4	1985-9	1990-4	1995-9	2000-4	2005-9	2010-3
Mallard	X	X	X	X	X	X	X
Blue-winged Teal	X	X	X	X	X	X	X
Cinnamon Teal	X	X	X	X	X	X	X
Northern Shoveler	X	X	X	X	X	X	X
Green-winged Teal	X	X	X	X	X	X	X
Northern Bobwhite							X
Pied-billed Grebe	X	X	X	X	X	X	X
American Bittern				X	X	X	X
Great Blue Heron	X	X	X	X	X	X	X
Black-crowned Night Heron	X	X	X	X	X	X	X
White-faced Ibis		X	X	X	X	X	X
Osprey	X		X	X	X	X	X
Northern Harrier	X	X	X	X	X	X	X
Cooper's Hawk			X				X
Swainson's Hawk	X	X	X	X	X	X	X
Red-tailed Hawk	X	X	X	X	X	X	X
Virginia Rail	X	X		X	X	X	X
Sora	X	X		X	X	X	X
American Coot	X	X	X	X	X	X	X
Killdeer	X	X	X	X	X	X	X
American Avocet	X			X		X	X
Long-billed Curlew			X	X	X	X	X
Spotted Sandpiper	X	X	X	X	X	X	X
Wilson's Snipe	X	X	X	X	X	X	X
Rock Pigeon	X	X	X	X	X	X	X
Eurasian Collared-Dove						X	X
Mourning Dove	X	X	X	X	X	X	X
Great Horned Owl	X	X	X	X	X	X	X
Burrowing Owl	X	X	X	X	X	X	X
Common Nighthawk	X	X	X	X	X	X	X
Belted Kingfisher	X	X	X	X	X	X	X
Lewis's Woodpecker	X						
Red-headed Woodpecker							X
Downy Woodpecker	X	X	X	X	X	X	X
Northern Flicker	X	X	X	X	X	X	X
American Kestrel	X	X	X	X	X	X	X
Western Wood-Pewee	X	X	X	X	X	X	X
Say's Phoebe	X	X	X		X	X	X
Western Kingbird	X	X	X	X	X	X	X
Eastern Kingbird	X	X	X	X	X	X	X
Loggerhead Shrike	X	X			X	X	X
Warbling Vireo	X	X	X	X	X	X	X
Blue Jay	X	X	X	X		X	X
Black-billed Magpie	X	X	X	X	X	X	X
American Crow	X	X	X	X	X	X	X

Species	1980-4	1985-9	1990-4	1995-9	2000-4	2005-9	2010-3
Horned Lark	X	X	X	X	X	X	X
Tree Swallow	X	X	X	X	X	X	X
N. Rough-Winged Swallow	X	X	X	X	X	X	X
Cliff Swallow	X	X	X	X	X	X	X
Barn swallow	X	X	X	X	X	X	X
Black-capped Chickadee	X	X	X	X	X	X	X
White-breasted Nuthatch		X			X		X
Rock Wren	X	X					
House Wren	X	X	X	X	X	X	X
Marsh Wren			X		X	X	X
Blue-gray Gnatcatcher						X	X
Mountain Bluebird	X	X	X	X	X	X	X
American Robin	X	X	X	X	X	X	X
Gray Catbird						X	X
European Starling	X	X	X	X	X	X	X
Cedar Waxwing							X
Common Yellowthroat	X	X	X	X	X	X	X
Yellow Warbler	X	X	X	X	X	X	X
Green-tailed Towhee	X	X					X
Spotted Towhee	X	X	X	X	X	X	X
Vesper Sparrow	X	X		X	X	X	X
Lark Sparrow	X	X	X	X	X	X	X
Lark Bunting	X	X		X	X	X	X
Savannah Sparrow	X	X		X	X	X	X
Grasshopper Sparrow	X	X	X			X	X
Song Sparrow	X	X	X	X	X	X	X
Black-headed Grosbeak	X	X	X	X	X	X	X
Blue Grosbeak	X	X		X		X	X
Dickcissel							X
Bobolink	X					X	X
Red-winged Blackbird	X	X	X	X	X	X	X
Western Meadowlark	X	X	X	X	X	X	X
Yellow-headed Blackbird	X	X	X	X	X	X	X
Brewer's Blackbird	X	X	X	X	X	X	X
Common Grackle	X	X	X	X	X	X	X
Brown-headed Cowbird	X	X	X	X	X	X	X
Bullock's Oriole	X	X	X	X	X	X	X
Orchard Oriole							X
House Finch	X	X	X	X	X	X	X
Lesser Goldfinch		X		X			X
American Goldfinch	X	X	X	X	X	X	X
House Sparrow	X	X	X	X	X	X	X

¹ The Boulder County monthly wildlife inventory is an informal compilation of bird sightings submitted by local volunteers to the Boulder County Audubon Society. Since there are no controls on the amount of observer effort, these observations are more suggestive of the presence of, rather than the absence of, individual species. Observers report their sightings monthly from 50 mapped areas within Boulder County.

Wood Ducks, Blue Jays, and Orchard Orioles are native to eastern North America, and their numbers have increased throughout eastern Boulder County since 1980 as native cottonwoods and non-native willows have proliferated along prairie streams (Boulder County Audubon Society 1979-2013, National Audubon Society 2013). Northern Bobwhites and Red-headed Woodpeckers are rare and declining nesting species in Boulder County (Hallock and Jones 2010), and each was reported only once within the study area during 2000-13.

Eurasian Collared-Doves are native to the Indian subcontinent and were first reported in North America during the 1980s, when caged birds imported to the Bahamas somehow made their way to Florida (Fuller 2004). They have since radiated out throughout much of North America, including Alaska (Fuller 2004). Blue-grey Gnatcatchers and Gray Catbirds are native shrub-nesters whose numbers may have increased in Boulder County in recent decades as cattle were removed from plains and foothills shrubland areas, enabling shrub-nesting habitat to expand (Boulder County Audubon Society 1979-2013; Chase and Cruz 2013).

Dickcissels nest in tallgrass prairies and disturbed agricultural fields throughout the central and eastern Great Plains (Kingery 1998b). Singing males occasionally irrupt into Boulder County during late spring and early summer of years when drought conditions impact large areas of the Great Plains (Kingery 1998b, Boulder County Audubon Society 1979-2013). Dickcissels have never been documented nesting successfully in Boulder County (Hallock and Jones 2010).

Several potential nesting species, including Blue-winged Teal, Cinnamon Teal, Northern Harrier, and Burrowing Owl, were reported more frequently within the study area during 1980-99 than during 2000-13 (Boulder County Audubon Society 1979-2013). See the Species of Special Concern section on page 29 for a discussion of some of these species. Lewis's Woodpecker was reported once within the study area, in October 1984. Mature cottonwoods along the shoreline of Coot Lake could constitute potential nesting habitat (Kuenning 1998). Rock Wrens were reported within the study area during the 1980s and 1990s but haven't been reported since 2000. They typically choose broken cliffs for nesting, but they can also nest on talus slopes and dam abutments (Jones 1998), so periodic nesting at the reservoir is conceivable.

Nesting Bird Population Densities

Table 5 shows estimated breeding season (June-July) population densities of the 13 most abundant species observed during 2013, derived from distance sampling and analysis in the program Distance

(Thomas et. al. 2010), employing a half-normal cosine model. Distance is a Windows-based computer package developed in Scotland to analyze distance-sampling surveys of wildlife populations. The program examines the numbers of a given species observed at various distances and then assigns a detectability index to each species. The index is applied to estimate the absolute density of a given species within the survey area (Thomas et. al. 2010).

Table 5. Estimated density/ha of most abundant species.

Species	Number/point/survey	Estimated density/ha	Density Range at 0.95 confidence interval ¹	Coefficient of Variation ²
Red-winged Blackbird	5.12	8.048	6.678 - 9.698	.095
Cliff Swallow	4.30	3.405	2.226 - 5.207	.218
American Goldfinch	0.79	1.811	1.268 - 2.586	.179
Canada Goose	2.61	1.771	.781 - 4.016	.428
Common Grackle	0.79	1.725	.880 - 3.382	.344
American Robin	0.49	.792	.518 - 1.209	.210
Brown-headed Cowbird	0.59	.690	.515 - .923	.144
Mallard	1.19	.489	.182 - 1.312	.531
Common Yellowthroat	0.95	.435	.322 - .588	.151
Yellow Warbler	0.77	.402	.311 - .519	.129
Mourning Dove	0.90	.371	.237 - .579	.224
Killdeer	0.52	.348	.159 - .763	.402
Western Meadowlark	1.41	.180	.131 - .246	.160

According to the analysis in Distance, Red-winged Blackbird was by far the most abundant breeding species within the study area, followed by Cliff Swallow, American Goldfinch, Canada Goose, and Common Grackle. However, the software is much better at estimating populations of smaller songbirds which tend to be evenly distributed within a given habitat type than of ducks and other larger birds that may aggregate into summer flocks. Since most of the Canada Geese and Mallards counted from point-count stations in June and July had already aggregated into flocks and most sightings were at a distance of > 100 m from the observer, estimates of absolute density of these species within the study are unreliable (see Density Range and Coefficient of Variation columns in Table 6). In addition, Distance can generally make reliable density estimates only when provided with at least 60 observations of a given species. Of the songbirds observed from point-count stations, only Cliff Swallow, Red-winged Blackbird, and Western Meadowlark met this criterion (see Number/Point/Survey column).

Nevertheless, the analysis does suggest that Red-winged Blackbird is by far the most abundant nesting songbird species within the study area, followed in estimated density by Cliff Swallow, American Goldfinch, Common Grackle, American Robin, Brown-headed Cowbird, Common Yellowthroat, Yellow Warbler, Mourning Dove, and Western Meadowlark. Of these 10 species, two nest predominantly in marshes (Common Yellowthroat and Red-winged Blackbird), one nests predominantly in riparian woodlands (Yellow Warbler), one nests predominantly in a mixed grasslands (Western Meadowlark),

and the remaining six are habitat generalists that nest in a wide variety of ecosystems, including urban areas (Kingery 1998).

These estimated densities reflect the proximity of Boulder Reservoir to several urban areas, the presence within the study area of buildings, bridges, and other structures where urban-adapted generalists often nest, and the coverage of much of the study area by cattail marshes and mixed grasslands. While these data may be of limited value when analyzing habitat quality and management, they do provide a baseline for comparing Boulder Reservoir bird populations over time and with bird populations within other semi-urban parks throughout Colorado. For example, a future decrease in the density of Common Grackles and Brown-headed Cowbirds might indicate a reduction in the amount of native habitat fragmentation within the study area.

Nesting Bird Concentration Areas

Highest numbers of potentially breeding birds were observed in wetlands and cottonwood groves in the Dry Creek drainage and shoreline area at the northwest corner of the reservoir, the Little Dry Creek south inlet at the southwest corner of the reservoir, and the wetlands to the west of Coot Lake (Tables 6 and 7; Appendix IV). During May and June the Dry Creek inlet supported at least 21 species of foraging waterfowl, waders, and shorebirds, including Blue-winged Teal, Cinnamon Teal, Northern Shoveler, Green-winged Teal, Great Egret, White-faced Ibis, American Avocet, and Semipalmated Plover (Table 11). However, of the waterfowl, herons, and shorebirds observed within the inlet, only Canada Goose, Mallard, Killdeer, Spotted Sandpiper, and Wilson's Snipe appear to have nested successfully.

Shallows and wetlands on the west side of Coot Lake supported concentrations of migratory waterfowl and grebes, including Canada Goose, Mallard, Redhead, Lesser Scaup, Greater Scaup, Ring-necked Duck, Common Merganser, Red-breasted Merganser, Eared Grebe, and Western Grebe. However, of these species only Canada Goose and Mallard demonstrated behaviors (such as territorial defense or fledged young) consistent with actually nesting in these wetlands.

Crowded cattail marshes in the Little Dry Creek drainage appear to support lower numbers of nesting species and individuals than do the more vegetatively complex marshes in the Dry Creek drainage and west of Coot Lake. The Dream Cove area, just northeast of the Boulder Reservoir entrance gate, supported relatively high numbers of individuals during both migratory and breeding bird surveys; however, nearly two-thirds of these birds were urban-adaptive generalists such as Canada Goose, Mallard, American Robin, and European Starling.

Areas of steeper shoreline along the west and north shores of the reservoir supported relatively low numbers of migratory and nesting birds. In these areas, the "bathtub ring effect"--whereby large areas of bare shore are exposed in early spring and create an inhospitable barrier between the reservoir surface and any sheltering shoreline vegetation--probably precludes successful nesting by most ducks and shorebirds.

Table 6. Breeding Season (June-July) Point-Count Summary. From three, 10-minute counts (11-12 June, 28-29 June, 12-13 July).

Point No.	Location	Mean Species	Mean Individuals	Total Species	CNHP Tracked ¹	BCNA Concern ²	Non-Native ³
1	L. Dry Creek south inlet	10.7	29.7	16	0	0	1
2	L. Dry Creek overlook	11.0	40.0	19	1	0	2
3	L. Dry Creek marsh south	8.7	18.7	14	0	0	0
4	L. Dry Creek marsh north	8.0	18.3	15	0	0	0
5	L. Dry Creek north inlet	9.7	25.0	16	1	1	1
6	West shore	6.3	14.3	12	0	0	0
7	Dry Creek inlet south	10.3	30.7	16	2	0	2
8	Anthill drainage	9.3	24.7	15	0	0	1
9	Dry Creek east	10.3	31.0	20	0	1	0
10	Dry Creek west	7.3	17.7	15	0	0	0
11	Dry Creek inlet north	12.0	31.0	23	0	0	1
12	North shore	5.3	18.7	11	0	0	0
13	North inlet marsh	9.3	26.7	16	0	0	0
14	Coot Lake marsh north	10.3	27.7	19	0	0	0
15	Coot Lake marsh south	10.0	22.3	18	0	1	0
16	Coot Lake southeast	8.0	15.0	15	0	0	1
17	North dam drainage	8.0	28.0	15	0	0	1
18	South dam drainage	6.0	17.0	12	0	0	0
19	Marina/south dam	8.3	18.3	17	0	1	2
20	Dream Cove	11.7	53.3	21	0	0	2

¹ Colorado Natural Heritage Program. 2012. Tracked bird species.

² Hallock, D., and S. R. Jones. 2010. Boulder County avian species of special concern. Boulder County Nature Series: No. 1. Boulder County Nature Association, Boulder, Colorado.

³ Species nesting at significantly higher densities within urban and rural residential areas than in other areas of Colorado (Kingery. 1998).

Table 7. Breeding Season (June-July) Point-Count Summary Detail

Point No.	Location	Dominant Habitats ¹	Mean Ind. ²	% CNHP Tracked ³	% Urban-adapted ⁴	% Non-Native ⁵
1	L. Dry Creek south inlet	Emergent marsh, shoreline, open water, riparian woodland, rural residential	29.7	0.0	34 .4	1.1
2	L. Dry Creek overlook	Mixed prairie, emergent marsh, shoreline, open water, barren ground	40.0	0.8	58 .6	4.3
3	L. Dry Creek marsh south	Emergent marsh, riparian woodland, mixed prairie	18.7	0.0	12.5	0.0
4	L. Dry Creek marsh north	Emergent marsh, mixed prairie	18.3	0.0	18.2	0.0
5	L. Dry Creek north inlet	Emergent marsh, mixed prairie, riparian woodland	25.0	0.0	13.3	1.3
6	West shore	Open water, shoreline, riparian woodland, mixed prairie	14.3	0.0	4.7	0.0
7	Dry Creek inlet south	Shoreline, riparian woodland, emergent marsh	30.0	0.0	44.6	1.1
8	Anthill drainage	Emergent marsh, mixed prairie, riparian woodland	24.7	0.0	12 .0	10.7
9	Dry Creek east	Emergent marsh, rip. woodland, shoreline, mixed prairie	31.0	0.0	14 .3	0.0
10	Dry Creek west	Emergent marsh, mixed prairie	17.7	0.0	9 .7	0.0
11	Dry Creek inlet north	Shoreline, open water, emergent marsh, riparian, mixed prairie	31.0	0.0	20 .7	0.0
12	North shore	Open water, shoreline, riparian woodland	18.7	0.0	12 .1	0.0
13	North inlet marsh	Riparian, emergent marsh, mixed prairie	26.7	0.0	13 .8	0.0
14	Coot Lake north	Riparian, emergent marsh, agricultural, barren ground	27.7	0.0	7.4	0.0

Point No.	Location	Dominant Habitats	Mean Individ.	% CNHP Tracked	% Urban-adapted	% Non-Native
15	Coot Lake marsh south	Emergent marsh, barren ground, riparian woodland	22.3	0.0	8.0	0.0
16	Coot Lake southeast	Open water, shoreline, barren ground, riparian woodland	15.0	0.0	42.2	4.4
17	North dam drainage	Emergent marsh, mixed prairie	28.0	0.0	5.9	2.4
18	South dam drainage	Mixed prairie, alkali marsh, barren ground	17.0	0.0	12.2	0.0
19	Marina/south dam	Open water, shoreline, barren ground, rural, riparian woodland	18.3	0.0	43.6	9.1
20	Dream Cove	Open water, shoreline, riparian woodland, barren ground	53.3	0.0	70.4	1.2

¹ Habitats present within 200 m radius of point-count station.

² Mean individuals per survey.

³ Colorado Natural Heritage Program. 2012. Tracked bird species.

⁴ Species nesting at significantly higher densities within urban and rural residential areas than in other areas of Colorado (Kingery. 1998).

⁵ Species not documented breeding in Colorado prior to 1900 (Henderson 1908, Sclater 1912, Kingery 1998).

Though we observed a few Horned Larks, Vesper Sparrows, Lark Sparrows, Grasshopper Sparrows, and several dozen Western Meadowlarks around the reservoir, breeding densities of these grassland-nesting species appear to be low compared to densities in more natural prairies east of Boulder County (Kingery 1998). Grasslands surrounding Boulder Reservoir are dominated by non-native grasses and may provide poor nesting structure and foraging opportunities for most grassland-nesting birds.

Migratory Bird Concentration Areas

Tables 8-9 summarize results of point counts conducted during the April-May spring migration season. Plots 7 and 11, which lie on the shoreline of the Dry Creek/North inlet, supported the highest mean numbers of species and individuals, as well as the most total species (Table 9). These plots also supported relatively low percentages of urban-adapted and non-native species. Plots 1-5, in the Dry Creek marsh and Little Dry Creek north and south inlets, supported substantially lower mean numbers of species and individuals, along with substantially fewer total species and higher percentages of urban-adapted and non-native species.

Table 8. Spring migration (April-May) point-count summary. Counts conducted on 23-25 April and 12-14 May.

Point No.	Location	Mean Species	Mean Individuals	Total Species	CNHP Tracked ¹	BCNA Concern ²	Non-Native ³
1	L. Dry Creek south inlet	8.0	22.5	11	0	0	2
2	L. Dry Creek overlook	5.5	12.0	9	0	0	1
3	L. Dry Creek marsh south	6.5	15.5	12	0	0	0
4	L. Dry Creek marsh north	5.5	16.0	8	0	0	0
5	L. Dry Creek north inlet	5.0	17.5	9	0	1	0
6	West shore	5.0	7.5	10	0	0	0
7	Dry Creek inlet south	11.0	29.5	20	2	0	1
8	Anthill drainage	5.0	15.5	8	0	0	0
9	Dry Creek east	5.0	14.5	8	0	0	1
10	Dry Creek west	4.5	16.5	7	0	0	0
11	Dry Creek inlet north	9.0	29.0	15	1	0	0
12	North shore	3.0	12.0	6	0	0	0
13	North inlet marsh	7.5	16.5	12	0	0	1
14	Coot Lake marsh north	8.0	22.0	13	0	1	0
15	Coot Lake marsh south	8.0	20.5	13	0	1	0
16	Coot Lake southeast	7.5	15.0	12	0	0	1
17	North dam drainage	6.5	29.0	10	0	1	0
18	South dam drainage	4.0	6.5	7	0	0	0
19	Marina/south dam	5.0	8.5	8	0	0	2
20	Dream Cove	9.0	18.0	14	0	0	0

Table 9. Spring migration (April-May) point-count detail.

Point No.	Location	Dominant Habitats ¹	Mean Ind. ²	% CNHP Tracked ³	% Urban-adapted ⁴	% Non-Native ⁵
1	L. Dry Creek south inlet	Emergent marsh, shoreline, open water, riparian woodland, rural residential	22.5	0.0	31.1	8.8
2	L. Dry Creek overlook	Mixed prairie, emergent marsh, shoreline, open water, barren ground	12.0	0.0	41.7	4.2
3	L. Dry Creek marsh south	Emergent marsh, riparian woodland, mixed prairie	15.5	0.0	9.7	0.0
4	L. Dry Creek marsh north	Emergent marsh, mixed prairie	16.0	0.0	15.6	0.0
5	L. Dry Creek north inlet	Emergent marsh, mixed prairie, riparian woodland	17.5	0.0	14.3	0.0
6	West shore	Open water, shoreline, riparian woodland, mixed prairie	7.5	0.0	0.0	0.0
7	Dry Creek inlet south	Shoreline, riparian woodland, emergent marsh	29.5	39.9	3.4	0.0
8	Anthill drainage	Emergent marsh, mixed prairie, riparian woodland	15.5	0.0	3.2	0.0
9	Dry Creek east	Emergent marsh, rip. woodland, shoreline, mixed prairie	14.5	0.0	3.4	3.4
10	Dry Creek west	Emergent marsh, mixed prairie	16.5	0.0	3.4	0.0
11	Dry Creek inlet north	Shoreline, open water, emergent marsh, riparian, mixed prairie	29.5	6.9	3.4	6.8
12	North shore	Open water, shoreline, riparian woodland	12.0	0.0	54.1	0.0
13	North inlet marsh	Riparian, emergent marsh, mixed prairie	15.5	0.0	30.3	12.1
14	Coot Lake north	Riparian, emergent marsh, agricultural, barren ground	22.0	0.0	29.5	0.0
15	Coot Lake marsh south	Emergent marsh, barren ground, riparian woodland	20.5	0.0	24.4	0.0

Point No.	Location	Dominant Habitats	Mean Indiv.	% CNHP Tracked	% Urban-adapted	% Non-Native
16	Coot Lake Southeast	Open water, shoreline, barren ground, riparian woodland	15.0	0.0	37.0	3.3
17	North dam drainage	Emergent marsh, mixed prairie	29.0	0.0	41.7	2.4
18	South dam drainage	Mixed prairie, alkali marsh, barren ground	6.5	0.0	13.1	0.0
19	Marina/south dam	Open water, shoreline, barren ground, rural, riparian woodland	8.5	0.0	52.9	11.8
20	Dream Cove	Open water, shoreline, riparian woodland, barren ground	18.0	0.0	55.5	0.0

To better document the differences among water-dependent bird populations within these two drainages and three inlets, I conducted 10-minute counts of all ducks, grebes, waders, and shorebirds observed within the inlets (from the shoreline eastward to the buoys separating the inlets from the rest of the reservoir) from points 1 and 2, 5 and 6, and 7 and 11 during each of four bird surveys in May, June and July (Table 10). During these surveys, I observed a total of 21 waterfowl, heron, and shorebird species within the Dry Creek inlet compared to only 8 within the Little Dry Creek north inlet and only 7 within the Little Dry Creek south inlet. Birds observed within the Dry Creek inlet included two Colorado Natural Heritage Program tracked species (American White Pelican and White-faced Ibis), and a Boulder County Nature Association species of special concern (Great Egret).

Characteristics which may attract more waterfowl, herons, and shorebirds to the Dry Creek inlet than to the Little Dry Creek inlets include a gradually sloping shoreline, presence of extensive mud flats and a significant area of shallow water offshore, and presence of native shrubs and sedge/rush wetlands close to the shoreline. Summer aerial photos of this inlet from Google Earth show a plume of brownish silt emanating from the mouth of Dry Creek and spreading out across most of the inlet, whereas no such silt plume appears on comparable aerial photos of the Little Dry Creek north and south inlets.

In 1987 the City of Boulder, acting in consultation with the Boulder County Nature Association, installed check dams across formerly channelized Little Dry Creek upstream from North 51st Street to create a new cattail marsh. This marsh, another marsh along Dry Creek west of North 53rd Street, and the wetlands west of Coot Lake were created to mitigate for loss of wetlands resulting from hardening of the Boulder Reservoir spillway and a consequent raising of the reservoir water level by up to 4 feet. It's possible that the diversion of water flows from formally channelized Little Dry Creek into the newly created marshes eliminated much of the flow of silt from this creek into the reservoir inlets, indirectly leading to a steepening of shoreline areas or deepening of near-shoreline waters.

Table 10. Mean number of of ducks, waders, and shorebirds observed in three west shore inlets during four May, June, and July 2013 bird surveys.¹

Species	Dry Creek Inlet	Little Dry Creek North Inlet	Little Dry Creek South Inlet
Canada Goose	5.3	4.3	13.3
Gadwall	0.8		
Mallard	7.5	0.8	12.0
Blue-winged Teal	1.3		
Cinnamon Teal	0.3		
American Wigeon	0.8		
Northern Shoveler	0.5		
Northern Pintail	0.8		
Green-winged Teal	1.3		
Western Grebe	0.8	0.5	0.5
Clark's Grebe	0.3		
Double-crested Cormorant	0.5	0.8	
American White Pelican	2.3	1.0	0.8
Great Blue Heron	0.3		0.3
Great Egret	0.5		
White-faced Ibis	4.5		
Semipalmated Plover	0.5		
Killdeer	0.8	1.3	1.3
American Avocet	1.5		
Spotted Sandpiper	5.3	1.8	0.8
Baird's Sandpiper	0.5	0.5	

¹ Mean number per survey. Dry Creek 13 May, 12 June, 29 June, 13 July; Little Dry Creek north 14 May, 10 June, 29 June, 11 July; Little Dry Creek south 14 May, 12 June, 27 June, 11 July.

In addition, the presence of two Osprey nesting platforms on poles within 50 m of the shorelines of the Little Dry Creek inlets may discourage ducks and shorebirds from foraging there. Though Ospreys prey primarily on fish, they are opportunistic feeders and may harass foraging ducks and shorebirds (Poole, Bierregard, and Martel 2003).

Boulder County birdwatchers reported seeing Blue-winged Teal and Cinnamon Teal in the Little Dry Creek south inlet during most summers prior to 1990 (G. Brown, pers. comm.; Boulder County Audubon Society 1979-2013). These two native dabbling ducks typically nest in shoreline areas of shallow marshes, and they typically forage in waters shallow enough to enable them to tip their bodies and glean invertebrates and plants from the bottom (Boyle 1998, Kuenning 1998). Numbers of Boulder County Monthly Wildlife Inventory reports of these two species from Boulder Reservoir declined sharply after 1990 (Boulder County Audubon Society 1979-2013).

During April and May migratory bird surveys we also saw up to 75 geese, ducks, grebes, waders, and gulls floating on Coot Lake or wading near shore. Species observed included Canada Goose, Wood Duck, Gadwall, American Wigeon, Mallard, Redhead, Lesser Scaup, Greater Scaup, Common Merganser, Eared Grebe, Western Grebe, Clark's Grebe, Great Blue Heron, American Coot, and Ring-billed Gull. Most of these birds had departed by the first week of June, and of them only Canada Goose and Mallard appeared to nest within the Coot Lake wetlands.

Species of Special Concern

Wetlands on the west side of Boulder Reservoir and west of Coot Lake have been designated as Critical Wildlife Habitat in the Boulder County Comprehensive Plan due to the presence there of nesting American Bitterns (Boulder County isolated and restricted), Ospreys (Boulder County isolated and restricted), and Northern Harriers (Boulder County rare and declining; Hallock and Jones 2010).

During 2013 we identified three American Bittern nesting territories within the Dry Creek marsh area east and west of North 51st Street and a fourth American Bittern nesting territory in the Coot Lake wetlands (Figure 2). We detected no American Bitterns in the Little Dry Creek drainage, where calling bitterns were observed annually from 2004-09 and 2011-12 (Figure 3; Table 11; Jones 2006-13). The total of seven American Bittern nesting territories documented within wetlands surrounding Boulder Reservoir from 2004-13 comprises at least half of all American Bittern nesting territories reported in Boulder County from 1980-2013 (Hallock and Jones 2010, Jones 2006-13).

Two Osprey pairs nested near the reservoir during 2013, one pair on an artificial nest platform located on a pole in the Little Dry Creek marsh east of North 51st Street and the second pair on an artificial nest platform located on a pole on the Boulder Open Space and Mountain Parks Axelson property 50 m west of North 51st Street (Figure 4; Table 12). Both nests failed, the Little Dry Creek nest in early June after two young had been observed on the nest, and the Dry Creek nest in early June during incubation. Ospreys nested successfully around the reservoir from 2001-13 (Jones 2006-13). Nest productivity has declined from an average of 4.0 young fledged/year from 2004-10 to 2.0 fledged/year from 2011-13.

We observed a pair of foraging Northern Harriers flying low over and occasionally descending into the Little Dry Creek and Dry Creek cattail marshes throughout April and early May. However, we saw no evidence of nesting, and we observed no Northern Harriers within the study area during June or July. This is the second consecutive year that we have found no evidence of nesting in the marshes west of Boulder Reservoir, where Northern Harriers nested annually from 2004-11 (Figure 5; Jones 2006-13).

Northern Harriers nested successfully in the Coot Lake wetlands in 2004 (4 young fledged), in the Little Dry Creek cattail marsh in 2004 (4 young fledged) and 2009 (4 young fledged), and in the Dry Creek cattail marsh in 2010 (3 young fledged; Table 13). These are the only successful Northern Harrier nests that have been documented in Boulder County since 1987 (Hallock and Jones 2010, Jones 2006-13), and this species is critically imperiled in Boulder County.

Figure 2. American bittern 2013 observation locations.



Figure 3. American Bittern 2006-13 suspected territories, with years suspected active.¹



¹ One or more calling bittern heard; or pair or fledged young seen during documented breeding season.

Figure 4. Osprey 2004-13 nest locations.



Table 11. American Bittern 2004-13 nesting observations at Boulder Reservoir and Coot Lake.¹

Year	Little Dry Creek	Dry Creek	Coot Lake
2004	Territory ²	Inactive ³	2 young observed
2005	Territory	Inactive	Territory
2006	Territory	Territory	Territory
2007	Territory	1 young observed	Territory
2008	Territory	Territory	Territory
2009	Territory	Territory	Inactive
2010	Inactive	2 young observed	Territory
2011	Territory	2 territories	Territory
2012	Territory/pair	2 territories	Territory
2013	Inactive	3 territories	Territory/pair observed

¹ Jones, S.R. 2006-13. Boulder Reservoir species of special concern monitoring reports. Boulder Parks and Recreation Department, 3198 Broadway, Boulder Colorado 80304.

² Territory indicated by persistent calling of male bittern.

³ No individuals seen or heard.

Table 12. Osprey 2004-13 nesting observations at Boulder Reservoir.¹

Year	Little Dry Creek North Platform	Little Dry Creek South Platform	Dry Creek/Axelson
2004			2 young fledged
2005			2 young fledged
2006			2 young fledged
2007			4 young fledged
2008		3 young fledged	4 young fledged
2009	Nest failed	3 young fledged	3 young fledged
2010	Inactive	2 young fledged	3 young fledged
2011	Inactive	2 young fledged	Nest failed (incubation)
2012	3 young fledged	Canada Goose nest	Nest failed (incubation)
2013	Nest failed (2 young)	Canada Goose nest	Nest failed (incubation)

¹ Jones, S.R. 2006-13. Boulder Reservoir species of special concern monitoring reports. Boulder Parks and Recreation Department, 3198 Broadway, Boulder Colorado 80304.

Figure 5. Northern Harrier 2004-13 approximate nest locations.



Table 13. Northern Harrier 2004-13 nesting observations at Boulder Reservoir and Coot Lake.¹

Year	Little Dry Creek	Dry Creek	Coot Lake
2004	4 young fledged	Inactive ²	4 young fledged
2005	Pair observed	Inactive	Pair observed
2006	2 nests failed	Nest failed	Inactive
2007	Nest failed	Inactive	Inactive
2008	Nest failed	Nest failed	Inactive
2009	4 young fledged	Inactive	Inactive
2010	Inactive	3 young fledged	Inactive
2011	Inactive	Nest failed	Inactive
2012	Inactive	Inactive	Inactive
2013	Pair observed/no nest	Inactive	Inactive

¹ Jones, S.R. 2006-13. Boulder Reservoir species of special concern monitoring reports. Boulder Parks and Recreation Department, 3198 Broadway, Boulder Colorado 80304.

² No pair, territorial activity, or other signs of nesting observed.

A review of nesting records for Boulder County species of special concern in wetlands west of the reservoir from 2004-13 reveals a tendency of American Bitterns and Northern Harriers to nest less frequently in the Little Dry Creek cattail marshes and more frequently in the more vegetatively complex marshes of the Dry Creek drainage (Figures 2 and 5; Jones 2006-13). Crowded cattail growth within the Little Dry Creek drainage may be eliminating other marsh types (such as sedge/rush meadows and open water) and inhibiting foraging and nesting opportunities for marsh-dependent birds.

We also observed Northern Bobwhites (Boulder County rare and declining), Eared Grebes (Boulder County rare and declining), Bald Eagles (Boulder County isolated and restricted), Long-billed Curlews (Boulder County extirpated breeding populations), a Loggerhead Shrike (Boulder County rare and declining), Grasshopper Sparrows (Boulder County isolated and restricted), and a Bobolink (Boulder County isolated and restricted) within the study area (Figures 6-8; Table 14). Suitable nesting habitat for all of these Boulder County birds of special concern exists within the study area, but we did not confirm nesting for any of them. Detailed species accounts for birds of special concern that have nested or seem likely to nest within the study area follow below.

American Bittern (Boulder County isolated and restricted, USFS sensitive)

American Bitterns lay their eggs on platform nests constructed in dense emergent vegetation or, less frequently, in dense grasslands (Gibbs, Melvin, and Reid 2009). North American nesting success appears highest within large unfragmented marshes (Gibbs, Melvin, and Reid 2009). As a result of fragmentation and loss of wetlands, along with pesticide contamination and human disturbance of marshes, North American breeding populations have declined significantly since 1966 (Kingery 1998, Gibbs, Melvin, and

Table 14. Colorado Natural Heritage Program tracked birds and Boulder County Nature Association/Boulder County Parks and Open Space birds of special concern observed during 2013 surveys.

Colorado Natural Heritage Program Global Ranking Codes: G3, vulnerable to extirpation or extinction; G4, widespread, abundant, and apparently secure; G5, demonstrably widespread, abundant, and secure; T, rank applies to subspecies or variety.

State Ranking Codes: S1, state critically imperiled; S2, state imperiled; S3, state rare or uncommon; S4, state apparently secure; B, breeding populations; N, non-breeding populations.

Species	CNHP ¹	BCNA/BCPOS ²	Federal/State	USFS/BLM	Boulder Reservoir Status
Northern Bobwhite	---	Rare and Declining	---	---	Rare; no documentation of nesting
Eared Grebe	---	Rare and Declining	---	---	Fairly common migrant; no documentation of nesting
American White Pelican	G3;S1B	---	---	BLM	Summer resident non-breeder
American Bittern	---	Isolated and Restricted	---	USFS Sensitive	Four to five breeding territories annually in wetlands near reservoir ³
Great Egret	---	Isolated and Restricted	---	---	Summer visitor; nests at St. Vrain State Park
White-faced Ibis	G5;S2B	---	---	BLM	Summer visitor; no documentation of nesting
Osprey		Isolated and restricted			Nests annually on west side of reservoir.
Northern Harrier	---	Rare and declining; isolated	---	USFS Sensitive	Nests occasionally in wetlands surrounding reservoir ⁴
Bald Eagle	G5;S1B,S3N	Isolated and restricted	State concern	USFS Sensitive	Summer resident; nest failed in 2007.
Long-billed Curlew	G5;S2B	Extirpated nesting species	State concern	USFS Sensitive	Seen 22 April and 10 May 2013; marginal nesting habitat exists.
Forster's Tern	G5;S2B,S4N	---	---	---	Summer resident non-breeder
Loggerhead Shrike	---	Rare and declining; isolated	---	USFS Sensitive	Seen 25 April 2013; suitable nesting habitat may exist
Grasshopper Sparrow	---	Isolated and restricted	---	USFS Sensitive	Singing males 13 May and 2 June; suitable nesting habitat exists
Bobolink	G5;S3B	Isolated and restricted	---	---	No nesting habitat within study area.

¹ Colorado Natural Heritage Program. 2012. CNHP tracked bird species.

www.cnhp.colostate.edu/download/list/birds.asp

² Hallock, D., and S.R. Jones. 2010. Boulder County avian species of special concern. Boulder County Nature Association, www.bcna.org. Also included in Boulder County Comprehensive Plan.

³ Roughly half of the recently documented American Bittern nesting territories in Boulder County are in wetlands surrounding Boulder Reservoir (Hallock and Jones 2010, Jones 2006-12).

⁴ These nest sites, located in cattail marshes west and northeast of the reservoir, are the only documented successful Northern Harrier nesting sites in Boulder County since 1983 (Hallock and Jones 2010, Jones 2006-13).

Reid 2009). Sauer, Hines, and Fallon (2012) reported an annual rate of decline of nearly 1.8% from 1966-2011 on North American Breeding Bird Survey routes.

Strategies that increase the size of marshes and protect them from disturbance by humans and domestic dogs should benefit nesting bitterns. Although Boulder County populations appear to be stable (Hallock and Jones 2010), the species still appears limited to a dozen documented nesting sites in the county, and eight of these are in wetlands adjacent to Boulder Reservoir, privately-owned Six-Mile Reservoir, and Coot Lake. All of the known sites are in small (< 5 ha) cattail marshes near reservoirs or within floodplains, and most lie in areas that have been fragmented by mining, farming, roads, or trails.

All but one of the known sites (Six-Mile Reservoir) lie on public lands, but their vulnerability to urban-adapted predators and proximity to recreational trails may limit nesting success. Young bitterns are difficult to detect among the cattail foliage, and any attempt to count or band young would require disturbance of nesting areas. Therefore, it seems most prudent to continue to monitor sites from a non-intrusive distance, limit human encroachment within 200 m of any active nests, and strive to expand the areas of protected cattail marshes and surrounding wetlands.

White-faced Ibis (CNHP fully tracked, BLM tracked)

White-faced Ibis nest in scattered locations of eastern, southern, and northwestern Colorado in emergent wetlands often containing bulrushes and cattails (Ryder 1998). Breeding numbers vary dramatically from year to year depending on water levels in favored marshes (Ryder 1998).

We observed flocks of up to 75 White-faced Ibis flying over the Little Dry Creek drainage and wading in the shallows of the Dry Creek inlet during April and May. Cattail marshes within the Dry Creek drainage could provide suitable nesting habitat. However, there are no historical nesting records for White-faced Ibis anywhere in Boulder County, and the closest recently-documented nesting site is at Lower Latham Reservoir, 50 km northeast of the study area (Hallock and Jones 2010, Ryder 1998).

Osprey (Boulder County isolated and restricted)

Ospreys were first observed nesting near Boulder Reservoir in 1998 (Jones 2006-13). Though they nested historically in the mountains of the Colorado Front Range, there was no documentation of nesting on the plains of Boulder County before the mid-1990s (Hallock and Jones 2010). They have nested at four locations within 2 km of Boulder Reservoir (Figure 4):

1. Two artificial nest platforms erected on abandoned telephone poles by Boulder Parks and Recreation Department staff within the Little Dry Creek marsh area between North 51st Street and the reservoir shoreline .

2. An artificial nest platform erected by Boulder Parks and Recreation and Boulder Open Space and Mountain Parks staff on the Axelson Open Space property south of Dry Creek and approximately 50 m west of North 53rd Street.

3. An artificial nest platform on an abandoned telephone pole on the North Rim Open Space property approximately 1 km northwest of North 53rd Street.

4. A new nest, established in July 2013, on an active telephone line 80 m east of North 51st Street and 1.5 km south of the Boulder Reservoir entrance station. This nest was removed by Excel Energy shortly after it was constructed (Joy Master, Boulder Parks and Recreation, pers. comm.).

From 2004-10, the three nesting sites closest to the reservoir (the two platforms at Little Dry Creek and the platform near Dry Creek) fledged a total of 28 young. The Axelson/Dry Creek site was particularly productive, fledging 20 young from 2004-10. From 2011-13, these sites fledged only 5 young.

During 2013, all four active nests failed. The North Rim and Axelson nests apparently failed during incubation, the Little Dry Creek north site after we observed two chicks on the nest in early June, and the new site south of the reservoir failed when the nest was taken down by Excel Energy. The Little Dry Creek south platform was appropriated by a pair of Canada Geese during 2012-13. Reasons for nest failures at the previously productive Axelson site during 2011-13 are unknown, but it's possible that one of the original pair died and its replacement is either less fertile or less skilled at defending or provisioning a nest. The Little Dry Creek sites fledged 8 young during 2004-10 and 5 young during 2011-12 (Jones 2006-13).

Nest monitors noted one instance of a hiker illegally entering the Little Dry Creek wildlife closure area and flushing one of the Ospreys off the nest in May (see Management section for details). Monitors noted no instances of direct disturbance of the Dry Creek Osprey nest. However, while engaging in bird surveys, we frequently saw photographers parking illegally at the turn in the road to photograph the nest. Colorado State Parks and Wildlife recommends nest buffers (no human activity or occupation) of 400 m around active Osprey nests (Colorado Division of Wildlife 2008). This is not possible at Boulder Reservoir, since North 51st Street passes within 150 m of two nests and North 53rd Street (the northern continuation of North 51st) within 50 m of a nest. However, nesting Ospreys can habituate to human activities better than many other raptor species (Poole, Bierregard, and Martel 2003), so the current wildlife closure areas may be sufficient to protect nesting pairs.

Ospreys typically arrive at the reservoir in March and begin nest building in April. The following nesting chronology, based on observations at Boulder Reservoir from 2006-13, can inform decisions about seasonal closures:

Nest building: 20 March-30 July

Incubation: 5 April-11 June

Visible young on nest: 13 May-20 July

Fledged young: 26 July-12 August

I don't recommend that additional Osprey nesting platforms be erected on Boulder Parks and Recreation managed lands surrounding the reservoir. Though Ospreys prey primarily on fish, they are opportunistic feeders (Poole, Bierregard, and Martel 2003) and their presence close to the reservoir shoreline may discourage foraging and nesting by native waterfowl and shorebirds.

Northern Harrier (Boulder County rare and declining, USFS sensitive)

We began annual monitoring of nesting Northern Harriers within the study area in 2004, and 2012 and 2013 were the first years when we observed no evidence of attempted nesting (Table 13). Successful nesting occurred in the Coot Lake wetlands in 2004 (4 young fledged), in the Little Dry Creek wetlands in 2004 (4 young fledged) and 2009 (4 young fledged), and in the Dry Creek wetlands in 2010 (3 young fledged). Unsuccessful nesting occurred in the Little Dry Creek wetlands in 2005 and 2007-8 and in the Dry Creek wetlands in 2006, 2008, and 2011. The total of only 19 young fledged from all these nesting attempts since 2004 is probably not enough to sustain a viable nesting population (Johnsgard 1990).

In Boulder County Northern Harriers typically build their platform nests on the ground in cattail marshes. They were considered a "fairly common" local nesting species during the first decade of the 19th century (Henderson 2008), but their numbers appear to have dwindled steadily since then (Alexander 1937, Boulder County Audubon Society 1979-2013, Hallock and Jones 2010). The only Northern Harrier nests documented in Boulder County since 1979 have been in the cattail marshes west of Boulder Reservoir and west of Coot Lake and in a small cattail marsh west of Lagerman Reservoir. Only the Boulder Reservoir and Coot Lake nests have fledged young (Hallock and Jones 2010).

Nesting populations have also declined throughout many regions of North America. The North American Breeding Bird Survey (Sauer et. al. 2012) reported a 2% annual decline in Northern Harrier observations from 1966-2011 throughout the shortgrass and mixed-grass prairie region of the Great Plains. Fragmentation of wetland breeding habitats by agriculture, along with poisoning of rodent prey populations by herbicides and pesticides have probably contributed to this decline (Smith et. al. 2011).

It's likely that fragmentation of potential nesting habitat by roads, agriculture, and other human activities severely limits Northern Harrier nesting opportunities and nesting success in Boulder County. Nests situated in smaller, fragmented marshes may be more susceptible to predation by carnivores and raptors (Smith et. al. 2011). We've often observed coyotes nosing around Northern Harrier nesting areas west of the reservoir and Red-tailed Hawks harassing nesting harriers (Jones 2006-13).

Northern Harriers are considered fairly common in Boulder County during winter (Boulder County Audubon Society 2011), and during winters of 2004-13 as many as 15 harriers were observed roosting communally on the ground in cattail marshes west of the reservoir (Ted Floyd, pers. comm.). During the winter of 2012 only 1-2 roosting harriers were reported in these marshes (Boulder County Audubon Society 1979-2013). We suspect that low prey populations may have discouraged harriers from wintering in this area, and may also have discouraged them from nesting.

During April and May 2013, we observed what appeared to be a single pair hunting over marshes in the Little Dry Creek and Dry Creek drainages. This pair was observed by various monitors in May, but there were no reported observations in June or July. Low populations of Meadow Voles and other rodent prey, along with harassment by potential predators, may have discouraged harriers from nesting in these marshes during 2012-13.

Based on recent observations, Northern Harrier appears to be the most endangered nesting bird species in Boulder County (see Hallock and Jones 2010). Therefore, every conceivable effort should be undertaken to protect and expand potential nesting areas. Colorado State Parks and Wildlife give no specific nest buffer recommendation for this species, but they recommend nest buffers of 400 m (no surface occupancy beyond what historically occurred in the area) for similar-sized Swainson's Hawks, and 800 m buffers for Peregrine Falcon, Prairie Falcon, and Goshawk (Colorado Division of Wildlife 2008). So a 400 m buffer would seem a reasonable minimal guideline for Northern Harriers, especially since they are ground nesters particularly vulnerable to disturbance by roaming hikers and dogs.

In instances when pairs may choose to nest within 400 m of existing trails or other recreational facilities, seasonal closures of those facilities will contribute to nesting success. Raptors may be more inclined to abandon nesting sites during the nest-building and early incubation periods than during the chick-rearing period. In other words, their fidelity to the nest often increases as the chances of successfully fledging young increases (Colorado Division of Wildlife 2008; Craighead and Craighead 1965). The Northern Harrier nesting chronology, below, based on observations at Boulder Reservoir from 2006-13, can inform decisions about seasonal closures:

Nest building: 12 April-14 June

Incubation: 12 May-26 July

Feeding young on the nest: 25 May-7 July

Fledged (independently flying) young: 10 July-15 August

Encroachment by hikers and their dogs into the closed area surrounding the Dry Creek Northern Harrier nesting site was reported on several occasions by volunteers during the 2012 and 2013 nesting seasons (see Management section for details). Better enforcement of this closure would benefit nesting Northern Harriers, as would efforts to restrict human traffic passing near the Little Dry Creek and Dry Creek wetlands to the existing road right-of-way. Dogs should be leashed throughout the Northern Harrier nesting season (or until observations determine that harriers aren't nesting at the site) on the trail encircling the wetlands west of Coot lake. In addition, Boulder Parks and Recreation could meet

with Boulder Open Space and Mountain Parks to discuss possible ways of expanding the extent of marsh area within the Dry Creek wetland, both upstream and downstream from N. 53rd St.

Bald Eagle (Boulder County isolated and restricted, State concern, CNHP fully tracked, USFS sensitive)

Bald Eagles have been observed every winter at Boulder Reservoir since at least 1979 (Boulder County Audubon Society 1979-2013, Boulder County Nature Association 2012). In March 2007 a pair began constructing a nest on the Osprey nesting platform on the Axelson open space property 50 m west of North 53rd Street. This pair was displaced by a pair of nesting Ospreys by early April.

Bald Eagles were first documented nesting in Boulder County in 2002, and six pairs nested within the county in 2013 (Hallock and Jones 2010, Boulder Open Space and Mountain Parks 2013). Suitable nesting habitat (cottonwood groves within proximity to open water) exists within the study area.

Long-billed Curlew (Boulder County extirpated breeding populations, State concern, CNHP fully tracked, USFS sensitive)

Long-billed Curlews nested in Boulder County during the late 19th century (Henderson 1908), before most native prairies in the county were destroyed or severely fragmented by agricultural operations and urban growth. However, a few individuals still pass through the county during spring migration. We observed at least five Long-billed Curlews within the study area in April and May 2013 (Figure 7).

Long-billed Curlews typically nest in mixed-grass prairies close to shallow ponds or mud flats, where there is adequate cover for concealing their ground nests and barren ground where they can forage for invertebrates. They are considered an indicator of healthy native grasslands (Nelson 1998). Restoration of mixed-grass prairies surrounding Boulder Reservoir and Coot Lake to native grasses could create suitable nesting habitat for this species.

Burrowing Owl (Boulder County isolated and restricted, State threatened, USFS sensitive)

We observed no Burrowing Owls within the study area during 2013. Burrowing Owls nested successfully in the prairie dog colony east of the north dam and south of Coot Lake in 1988, 1989, and 2004; on the Boulder Reservoir north shore in 1982-3; and on the Axelson property northwest of Boulder Reservoir in 1986, 2007, and 2012 (Figure 7; Table 16; Jones and Mahoney 2003, Jones 2006-13).

Low fledge rates of nests during the past 20 years (Jones and Mahoney 2003, Boulder County Nature Association unpublished data) suggest that high mortality of young owls, possibly caused by predation, has contributed to low burrowing owl numbers throughout the county. A total of 46 nesting attempts observed within Boulder County from 2008-12 produced only 113 visible young (Table 17). This nest productivity is significantly below that reported for other High Plains burrowing owl populations (Johnsgard 1999) and may not be sufficient to maintain viable nesting populations.

Figure 6. Long-billed Curlew 2013 observation locations.



Figure 7. Burrowing Owl 2004-13 nest and sighting locations.

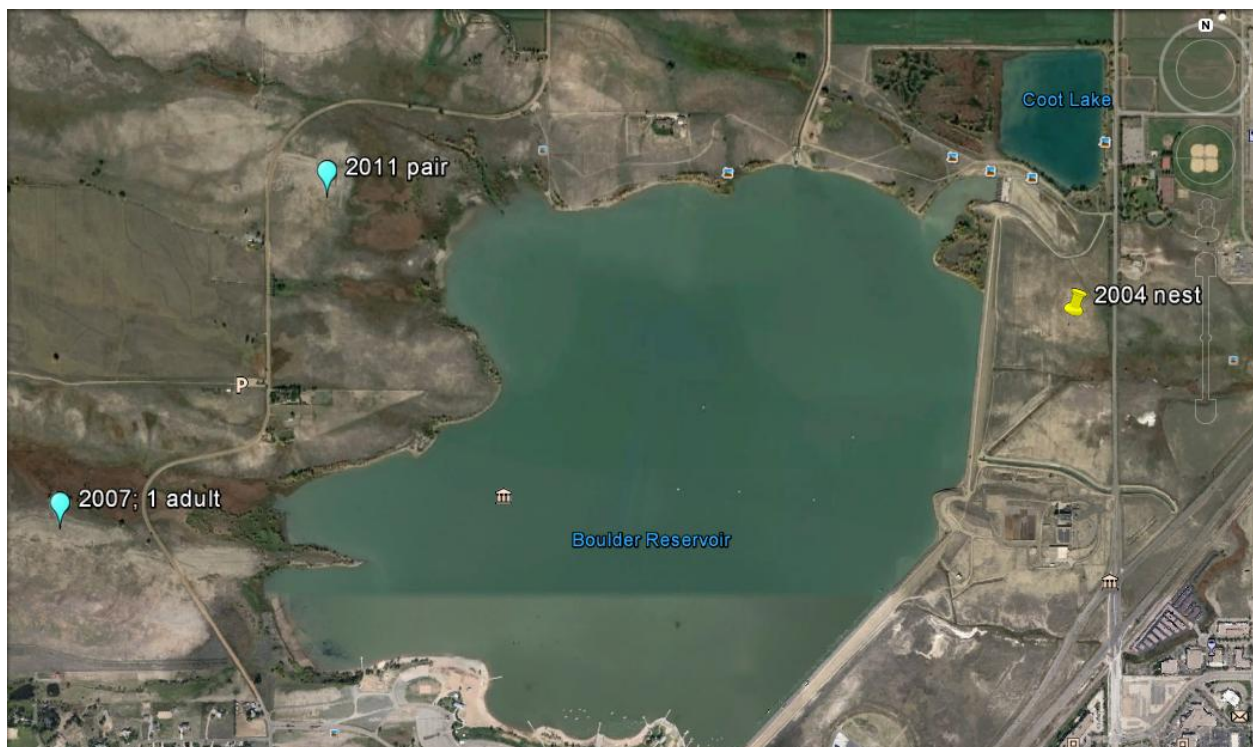


Table 15. 2004-13 Burrowing Owl observations.¹

Year	Little Dry Creek	Dry Creek	North Dam
2004	Inactive ²	Inactive	Nest with 3 young
2005	Inactive	Inactive	1 adult seen, 14 April
2006	Inactive	Inactive	Inactive
2007	1 adult seen	Inactive	Inactive
2008	Inactive	Inactive	Inactive
2009	Inactive	Inactive	Inactive
2010	Inactive	Inactive	Inactive
2011	Inactive	Pair, 16-20 April	Inactive
2012	Inactive	Inactive	Inactive
2013	Inactive	Inactive	Inactive

¹ Jones, S.R. 2006-13. Boulder Reservoir species of special concern monitoring reports. Boulder Parks and Recreation Department, 3198 Broadway, Boulder Colorado 80304.

² No pair, territorial activity, or other signs of nesting observed.

Though suitable nesting habitat (moderate to large-sized, active prairie dog colonies) for Burrowing Owls exists within the study area, this species is doing poorly throughout Boulder County, where nesting productivity may be limited by nesting habitat fragmentation and predation by urban-adapted carnivores (Hallock and Jones 2010, Jones 2012, Jones and Mahoney 2003).

Table 16. Burrowing Owl Nesting Success in Boulder County, 2007-12. Nesting attempts/total young observed.

Years	Boulder County Parks and Open Space ¹	Boulder Open Space and Mountain Parks ²	Boulder Parks and Recreation ³	Total
2008	NA	7/22	0/0	NA
2009	5/9	6/7	0/0	11/16
2010	5/12	5/10	0/0	10/22
2011	3/15	6/18	0/0	9/33
2012	6/9	3/11	0/0	9/20
2013	1/4		0/0	

Protection and conservation of prairie dog colonies around the reservoir may contribute to future burrowing owl nesting success, especially if prairie dog colonies are relatively large and buffered from disturbance. A variety of studies conducted on the Great Plains and in the Great Basin have determined that burrowing owl nesting success is positively correlated with the size of prairie dog colonies and the density of active burrows within colonies (Desmond, Savidge, and Eskridge 2000; Lantz, Smith, and Keinath 2004); and negatively correlated with the degree of fragmentation of grassland habitat and

proximity of human activity to existing nests (Haug 1985, Hughes 1993, Pezolesi 1994, Desmond, Savidge, and Eskridge 2000).

Burrowing Owls nesting in smaller prairie dog colonies appear more vulnerable to predation and have fewer potential nesting burrows to choose from (Desmond, Savidge, and Eskridge 2000; Lance, Smith, and Keinath 2004). In addition, larger numbers of Burrowing Owls nesting in larger prairie dog colonies may gain an advantage over predators through increased vigilance. American Badgers, Coyotes, Red Foxes, Red-tailed Hawks, and Great Horned Owls are considered significant predators of Burrowing Owls (Lance, Smith, and Keinath 2004). Automobiles also kill burrowing owls. Over a five-year period during the 1990s, 26 of 28 injured burrowing owls admitted to the Birds of Prey Rehabilitation Foundation in Broomfield, Colorado, had been struck by cars (Sigrid Ueblacker, pers. comm.).

No researchers have attempted to set a minimal or optimal size of prairie dog colonies used successfully for nesting by Burrowing Owls, but Lance, Smith, and Keinath (2004) identified the following indicators of suitable nesting habitat:

1. Open, dry, treeless areas on grasslands, shrublands, and desert floors.
2. Gentle slopes, short vegetation, high percentages of bare ground.
3. High densities of burrows.
4. Current activity of burrowing mammals, primarily prairie dogs.
5. Close proximity to other nesting Burrowing Owls
6. Dried manure from cows, horses, or bison.

Lance, Smith, and Keinath (2004) also synthesized a list of priorities for nesting burrowing owl habitat enhancement and conservation:

1. Maintain prairie dog colonies through landowner agreements and habitat management plans.
2. Designate 1/4-mile to 1/2-mile buffer zones around known Burrowing Owl nests where pesticide use, rodent control, and human disturbances are restricted.
3. Protect all known nest burrows, and retain prairie dog burrows as future nest burrows.
4. Maintain areas of short grass and open ground.
5. Do not eliminate prairie dogs and ground squirrels.
6. Avoid fragmenting habitat in known nesting areas. Roads, pipelines, plowing, and industrial developments will fragment burrowing owl nesting habitat and should be avoided in known nesting areas.
7. Delay spring mowing in hayfields until late July, avoid nighttime mowing, and space mowings widely apart throughout the season to allow higher likelihood of successful nesting.
8. Leave dirt berms along edges of cultivated fields.
9. Consider installing artificial nest burrows in areas where burrowing mammals have been exterminated and burrow availability has diminished.
10. Preserve rights-of-way, haylands, and uncultivated fields within 600 m of nests for foraging. Taller grasses may be grazed to attract primary burrowers such as prairie dogs.
11. Provide fresh cattle dung near nesting areas if dung is not available.

Colorado State Parks and Wildlife recommends no human occupancy or activity within 150 feet of active Burrowing Owl nests (Colorado Division of Wildlife 2008). Burrowing Owls typically arrive in Boulder County in April and begin nesting in late April or early May (Kingery 1998). The nesting chronology below, based on monitoring of Burrowing Owl nests on Boulder County Parks and Open Space properties from 2009-13 (Jones 2011-13), can inform decisions about seasonal closures:

Pairs first seen on territory: 15 April-9 May

Suspected incubation/brooding of young: 25 April-28 June

First visible young: 8 June-12 July

Young flying from natal burrow: 4 July-1 August

Loggerhead Shrike (Boulder County rare and declining, USFS sensitive)

Loggerhead Shrikes nest in shortgrass prairies throughout eastern Colorado and were considered common during the late 19th and early 20th century (Carter 1998). Their nesting habitat has been reduced by agricultural operations and nesting success has been impacted by pesticide poisoning of insect prey and collisions with automobiles (Ehrlich et. al. 1992). In Boulder County, known nesting has been documented during the past three decades (Hallock and Jones 2010).

We saw a single Loggerhead Shrike perched in a Russian-Olive in the small ravine that bisects the North dam north prairie dog colony on 24 April. We did not see any Loggerhead Shrikes on subsequent surveys. Small patches of shortgrass prairie nesting habitat exist within the study area, and as native prairies are restored and rehabilitated, opportunities for Loggerhead Shrike nesting should increase.

Grasshopper Sparrow (Boulder County isolated populations)

We heard Grasshopper Sparrows singing in mixed-grass prairies near the northeast corner of Coot Lake on 13 May and saw a pair in the same location on 2 June. Patches of suitable nesting habitat (bunch grasses interspersed with areas of bare ground) for Grasshopper Sparrows exist throughout the study area, so it's likely that they nest at least occasionally.

Bobolink (Boulder County isolated populations; CNHP fully tracked)

We observed a singing Bobolink (Boulder County isolated and restricted) on the fence separating Coot Lake from the open space property to the north on 2 June (Figure 8). In Colorado bobolinks nest primarily in irrigated hayfields and damp, grassy meadows. Isolated stalks of shrubs or forbs within the meadows serve as perch sites for singing males. Dense grassy cover around ground nests helps to conceal the nests from predators and enable adults to enter and exit the nests without being seen (Katempfer 1998).

Suitable nesting habitat (wet meadows) exists within the Dry Creek marsh, but no Bobolinks were seen or heard there, and Bobolinks have not been documented nesting within the study area.

Figure 8. Bobolink sighting location.



Rare Species

We observed a total of seven singing Dickcissels in clover and alfalfa meadows on Boulder Open Space and Mountain Parks property northwest of the reservoir and north of Coot Lake on 18 and 28 June, and a single singing male within the Coot Lake wetland on 28 June (Figure 8). During drought years on the southern and western plains, male Dickcissels occasionally irrupt into Boulder County, but nesting within the County has never been documented (Henderson 1908, Alexander 1937, Hallock and Jones 2010).

Figure 8. Dickcissel 2013 observation locations.



Management

Boulder Reservoir and its surrounding wetlands, grasslands, riparian woodlands, and shrublands support at least 224 species of breeding and migratory birds, including at least 12 potentially nesting Colorado Natural Heritage Program or Boulder County Nature Association birds of special concern. Health of wetlands on the west side of the reservoir and west of Coot Lake is particularly vital to regional bird populations, since these wetlands comprise the only recently successful Northern Harrier (Boulder County rare and declining) nest sites within Boulder County and support approximately half of recently documented American Bittern (Boulder County isolated and restricted) nesting territories (Hallock and Jones 2010). These wetlands also support nesting Ospreys (Boulder County isolated and restricted), foraging Bald Eagles (federal and state protected), foraging and potentially nesting White-faced Ibis (CNHP fully tracked), foraging American White Pelicans (state sensitive, CNHP fully tracked); nesting Blue-Winged Teal, Cinnamon Teal, Spotted Sandpipers, Soras, Virginia Rails, Common Yellowthroats, and Wilson's Snipe; and several dozen migratory duck, heron, and shorebird species. Therefore, protection and enhancement of these wetlands should be of primary importance.

Grasslands surrounding the reservoir tend to be dominated by non-native species and support relatively low populations of grassland-nesting birds. Enhancement of these grasslands through seeding of native grasses, removal of Russian-Olives and other invasive trees, and protection of restoration areas from prairie dogs should improve breeding conditions for native grassland-nesting birds.

Several small ravines cutting through the grasslands on the west, north, and east side of the reservoir support native shrub-nesting birds, including Common Yellowthroat, Yellow Warbler, Gray Catbird, Blue Grosbeak, and Bullock's Oriole. Removal of Russian-Olives and other non-native trees from these ravines, along with closing of social trails that fragment them, should also enhance habitat for native birds.

Management of visitor use poses a significant challenge, since Boulder Reservoir and Coot Lake are popular destinations for runners, bicyclists, dog-walkers and other recreationists; and since more than a dozen annual special events, including triathlons and half marathons, may draw thousands of visitors to the reservoir on weekends. While monitoring nesting birds of special concern in the Coot Lake, Dry Creek, and Little Dry Creek wetlands, volunteers observed frequent incursions of recreational users and their dogs into protected areas. These included the following:

1. Dogs running loose into the wetlands on the west side of Coot Lake. During April-May 2012 volunteers reported more than 30 instances of dogs off leash along the trail encircling the Coot Lake wetlands, which was clearly posted at the time as "on leash;" and three instances of dogs running into the wetland (Jones 2006-13). On 8 April Parks and Recreation Conservation Ecologist Joy Master (pers. comm.) reported that 17 of 19 groups walking their dogs on this trail were in violation of the leash requirement, and she saw two dogs running and swimming in the closed area.

2. Hikers and dogs walking along the shoreline in the closed area of the Dry Creek inlet. During May 2012 alone, bird monitors noted three instances of people and their dogs walking and playing along

the shore east of the Anthill, which lies in the middle of this wetland complex (Jones 2012). On 3 September 2013, while visiting the Dry Creek inlet area for just 20 minutes, I counted 10 hikers and 6 dogs within the closed area between the North Shore access trail and Dry Creek (see photos, Appendix I).

3. Hikers and dogs entering Little Dry Creek marsh east of North 51st Street. During May 2013, observers reported a hiker flushing a female Osprey off her nest while he was hiking illegally along the shoreline and an off-leash dog running through the Little Dry Creek prairie dog colony. Nesting Ospreys also appeared to increase alertness in response to loud music emanating from reservoir beaches (Jones 2006-13).

Since volunteer monitors visit the reservoir and Coot Lake for just a few hours per week during April-July, these anecdotal reports only hint at the extent of disturbance of nesting birds and other wildlife that may occur within closed areas. All of the wildlife closures are clearly posted with signs explaining the reasons for the restrictions. Therefore, it's likely that enhanced enforcement both of the closures and any on-leash requirements will be necessary to decrease the amount of disturbance of nesting wildlife within these wetlands and adjacent prairie dog colonies.

Management Recommendations

The following actions should improve nesting and foraging habitat for marsh-nesting, grassland-nesting, riparian nesting, and shrub-nesting birds--and particularly for birds of special concern--at Boulder Reservoir and on Boulder Parks and Recreation properties surrounding the reservoir:

1. Continue to protect marshes in the Little Dry Creek and Dry Creek drainages and in the Coot Lake wetlands from disturbance by recreational users and their pets. Continue to post these areas as sensitive wildlife habitat and prohibit all entry into them during the April-August nesting season. Require that dogs be leashed on trails passing around or close to these areas April-August.

2. Initiate autumn prescribed burns of cattail marshes in the Little Dry Creek drainage to reduce crowded and matted vegetation and provide space for other marsh vegetation. Consider using Bobcats or other relatively lightweight earth-moving equipment to create shallow ponds and gentle (50-75 cm above the summer high water level) knolls and serpentine ridges within these wetlands.

3. Work to restore grasslands surrounding the reservoir to a more natural condition. While continuing or accelerating the ongoing program of aggressive weed control, initiate annual seeding of native grasses and native forbs in disturbed areas where prairie dogs are not present. Use prairie dog fencing to protect these recently-seeded areas. Consider initiating spring burns on a rotational basis throughout grassland areas.

4. Develop a prairie dog management plan that includes goals for percentage occupancy (such as 10-25%) of grassland areas by prairie dogs; and establishes and maps prairie dog preserves, areas where prairie dogs will be tolerated but not encouraged, and areas from which prairie dogs will be actively removed.

5. Discourage visitor and off-leash dog incursion into wildlife habitat in the Dry Creek inlet area and along the reservoir north shore. Consider stronger enforcement of wildlife closures in this area

and/or establishing fees for using the north shore parking area (to counteract the tendency of more and more people to gravitate to this area to avoid the south shore entrance fees).

6. Close social trails around the reservoir north shore and Coot Lake. Re-institute the April-June (or until American Bittern or Northern Harrier young fledge) dogs-on-leash requirement for the trail encircling the Coot Lake wetlands.

7. Continue removal of Russian-Olives and other invasive tree species throughout the study area.

8. Continue using buoys to protect the Little Dry Creek and Dry Creek inlet waterfowl, heron, shorebird, and Osprey breeding and foraging areas from disturbance by recreational boaters April-August.

9. Continue annual monitoring of nesting success of Boulder County birds of special concern and Colorado Natural Heritage Program tracked species. Initiate a new program monitoring migrating and wintering water bird populations at the reservoir.

10. Continue the current, thoughtfully-executed program of posting informational and educational signs notifying users of the importance of Boulder Reservoir wetlands and grasslands to birds of special concern. Assign rangers to actively enforce closures and to educate the public about their importance.

Table 17. Restoration opportunities and management recommendations by management zone.

Management Zone	Characteristics	Conservation/Restoration Opportunities	Management Recommendations
Coot Lake and Wetlands	<ol style="list-style-type: none"> 1. American Bittern and Northern Harrier nesting habitat. 2. Marsh-nesting habitat for native songbirds. 3. Foraging and resting habitat for migratory ducks and shorebirds. 4. Extensive areas of bare and weed-infested ground along existing trails. 5. High levels of recreational use and high numbers of off-leash dogs throughout year. 	<ol style="list-style-type: none"> 1. Enhance protection of nesting habitat from disturbance by humans and their pets throughout April-August nesting season. 2. Improve marsh-nesting songbird habitat by removing non-native vegetation. 3. Diminish areas of trampled ground and invasive weeds surrounding lake and marsh. 	<ol style="list-style-type: none"> 1. Re-institute the dogs-on-leash regulation on trail surrounding marsh April-June (continuing until young bitterns or harriers have fledged). Heighten enforcement of dog regulations. 2. Continue removal of Russian-Olives and other non-native trees from marsh area. 3. Close social trails and erect fences or rock barriers to discourage users and their pets from wandering off trail. 4. Continue annual monitoring of nesting birds of special concern.
Dry Creek and Shoreline	<ol style="list-style-type: none"> 1. Critical nesting habitat for American 	<ol style="list-style-type: none"> 1. Enhance protection of critical nesting habitat from 	<ol style="list-style-type: none"> 1. Continue to preclude off-trail and off-road hiking

	<p>Bittern and Northern Harrier. Osprey nesting and foraging habitat.</p> <p>2. Great Blue Heron nesting colony.</p> <p>3. High-quality habitat for marsh-nesting and riparian-nesting songbirds.</p> <p>4. Shoreline and marsh habitat for foraging and nesting ducks, herons, and shorebirds, including several species of local and state concern.</p> <p>5. Degraded breeding habitat for grassland-nesting birds.</p>	<p>wandering hikers and dogs.</p> <p>2. Improve marsh-nesting and riparian-nesting habitat by controlling weeds and removing non-native trees.</p> <p>3. Improve protection of inlet foraging and nesting areas from wandering hikers and dogs.</p> <p>4. Restore degraded upland prairies to native prairie.</p>	<p>throughout the area, April-August.</p> <p>2. Remove Russian-Olives and other non-native trees from marsh area; accelerate efforts to control common teasel and other invasive weeds.</p> <p>3. Strengthen warnings along fenced area east of inlet to absolutely prohibit hikers and their pets from entering inlet and marsh wildlife areas. Heighten enforcement.</p> <p>4. Institute seeding of native grasses in upland areas south and west of the marsh area. Erect prairie dog fences to protect these areas from prairie dog incursion.</p> <p>5. Continue annual monitoring of nesting birds of special concern.</p>
Little Dry Creek and Shoreline	<p>1. Critical nesting habitat for American Bittern and Northern Harrier.</p> <p>2. Marsh and riparian breeding habitat for native songbirds.</p> <p>3. Crowded cattail marsh west of road supports relatively low densities of marsh-nesting birds.</p> <p>4. Lack of silt deposition in inlets limits quality of nesting and foraging habitat for native ducks and shorebirds.</p> <p>5. Non-marsh areas support extensive prairie dog colonies and severely degraded grasslands dominated</p>	<p>1. Enhance protection of marsh areas west and east of North 51st Street from disturbance by recreationists and their pets.</p> <p>2. Increase plant species diversity and decrease cattail density in cattail marsh west of North 51st Street.</p> <p>3. Investigate possibility of increasing silt flow into inlets without reducing extent of marsh vegetation east and west of North 51st Street.</p> <p>4. Increase percentage of native plants within wetland areas and adjacent grassland areas.</p> <p>5. Retain thriving prairie dog colonies while restricting their extent.</p>	<p>1. Continue to prohibit hiking within marsh areas throughout April-August nesting season. Heighten enforcement.</p> <p>2. Conduct fall burns in cattail marsh west of road. Consider using Bobcats or other lightweight equipment to create shallow ponds and drier knoll and ridge areas within this marsh.</p> <p>3. Initiate a study of silt flows from Little Dry Creek into the reservoir and investigate possibility of removing some check dams without decreasing extent of marsh vegetation.</p> <p>4. Continue weed control efforts within marsh and in adjacent grasslands, and</p>

	by non-native species.		<p>plant native grasses in disturbed areas outside prairie dog colonies.</p> <p>5. Institute prairie dog management plan that sets goals for extent of prairie dog colonies and designates both "prairie dog conservation" and "no prairie dog" areas.</p> <p>6. Continue annual monitoring of nesting birds of special concern.</p>
North Shore	<p>1. Shoreline areas and open water support nesting Spotted Sandpipers and migrating grebes.</p> <p>2. "Bathtub-ring" effect limits breeding opportunities for ducks and shorebirds.</p> <p>3. Degraded prairies limit breeding opportunities for grassland-nesting birds.</p> <p>4. Ravines and shoreline woodlands support small nesting populations of native songbirds.</p>	<p>1. Increase native shrub growth along shoreline.</p> <p>2. Restore areas impacted by social trails.</p> <p>3. Restore native vegetation to ravines and grassland areas.</p>	<p>1. Plant native willows and other native shrubs along shoreline.</p> <p>2. Close social trails.</p> <p>3. Remove Russian-Olives from ravine and shoreline areas, and plant native grasses in disturbed grasslands.</p>
South Dam	<p>1. Degraded grasslands and wetlands support nesting Vesper Sparrows, Blue Grosbeaks, and Meadowlarks.</p> <p>2. Alkaline marshes support low densities of nesting birds.</p> <p>3. Current uses of area, including water treatment facility and fire training station, limit native habitat restoration potential.</p>	<p>1. Where possible, restore degraded upland areas and marshes to native vegetation.</p> <p>2. Reduce extent of invasive weeds.</p>	<p>1. Continue aggressive weed control and removal of Russian-Olives throughout area.</p> <p>2. Institute prairie dog management plan that sets goals for extent of prairie dog colonies and designates both "prairie dog conservation" and "no prairie dog" areas.</p>

South Shore	<p>1. High use area is dominated by parking lots, beaches, and other recreational facilities. Loud noise from recreational events may disturb nesting Osprey and other birds.</p> <p>2. Riparian woodlands in Dream Cove area support relatively high densities of nesting songbirds; however, most are urban-adapted generalists.</p> <p>3. Small cattail marsh adjacent to entrance road supports nesting Canada Geese, Mallards, and blackbirds.</p>	<p>1. Enhance protection of existing cattail marsh and riparian areas from human disturbance.</p> <p>2. Strive to limit major recreational events and loud noises from music or other sources during the breeding bird season.</p>	<p>1. Post informational signs advising users not to enter cattail marsh and dense riparian area west of Dream Cove during April-August breeding season.</p> <p>2. Avoid scheduling major recreational events at the reservoir during the May-June heart of the breeding season for birds of special concern.</p> <p>3. Eliminate the playing of loud music from reservoir beaches during the May-June heart of the breeding season for birds of special concern.</p>
Boulder Reservoir Open Water	<p>1. More than 90 species of migrating duck, grebe, loon, heron, shorebird, and gull use the reservoir for resting and foraging.</p> <p>2. Rare migrants, including Tundra Swan, Pacific Loon, and Red-necked Grebe have been observed.</p> <p>3. Western Grebes, American White Pelican, and Common Mergansers float on the reservoir throughout the summer season.</p>	<p>1. Continue to provide safe havens (boating exclosures) for waterbirds around the various reservoir inlets and outlets.</p> <p>2. Monitor migrating water bird populations and map concentration areas.</p>	<p>1. Continue using buoys to restrict boating around the various reservoir inlets and outlets.</p> <p>2. Institute a program of annual monitoring of migrating and wintering water bird populations at the reservoir by volunteers. Use results to designate safe havens for migrating and wintering waterbirds.</p>

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Finally, I particularly appreciate the help of mathematician and longtime friend Benjamin Hoffman, who entered data into the Distance program and conducted the preliminary analysis of results.

Appendix I. Photos of Habitats and Birds



Little Dry Creek inlet and marsh from reservoir main entrance. Note prairie dog barrier fence.



Little Dry Creek cattail marsh west of North 51st Street, showing prairie dog colony (foreground) and dense cattail growth. Northern Harriers nested in this cattail marsh from 2004-09.



2008 failed Northern Harrier nest in Little Dry Creek cattail marsh 40 m west of North 51st Street.



Little Dry Creek north inlet from North 51st Street. Note Osprey nesting poles near center of photo.



Ferruginous Hawk in Little Dry Creek valley. Fairly common during winter at Boulder Reservoir during the 1990s, these large Buteos have become rare throughout Boulder County.



Ravine south and west of Anthill. Note Russian-Olives and non-native willows.



Dry Creek marsh showing sedge/rush meadow, cattail marsh, cottonwood groves, and Russian-Olives.



Young Northern Harriers on ground nest in Dry Creek cattail marsh, July 1987.



Osprey bringing nesting material to platform in eastern Boulder County. Gregg Goodrich courtesy photo.



Dry Creek inlet from North parking area. Note smooth brome-dominated non-native grassland and Russian-Olives.



Hikers walking within Dry Creek wildlife closure, 3 September 2013



Hikers and dogs within Dry Creek wildlife closure, 3 September 2013



American White Pelicans, Canada Geese, Cackling Geese, and various ducks in Dry Creek inlet, 3 September 2013.



American White Pelicans, Egret species, Canada Geese, and ducks in Dry Creek inlet. 3 September 2013.



Great Blue Heron with Ring-billed Gulls and Canada Geese in Dry Creek inlet, 3 September 2013.



Typical Cinnamon Teal nesting habitat (photographed at Lower Latham Reservoir in Weld County). Cinnamon and Blue-winged Teal have nested in the Little Dry Creek and Dry Creek wetlands, but habitat degradation appears to limit nesting opportunities.



Prairie Falcon soaring south of Monarch Road (800 m north of the study area). Both Prairie Falcons and Peregrine Falcons hunt at Boulder Reservoir.



American Bittern nesting territory in Coot Lake wetlands. Note Russian-Olives.



North dam north prairie dog colony. Most of the vegetation in the photo is comprised of non-native grasses and forbs, including Cheatgrass and Bindweed.



Mixed-grass prairie, marsh, and prairie dog colony east of south dam.

Appendix II. Point-Count Station Locations and Descriptions

1. 13T 0479998E; 4435875N. 5183'. Willow sapling in willow thicket 30 m south of shoreline and 100 m north of reservoir entrance road. Emergent wetland, willow carr, riparian woodland, open water.
2. 13T 0479774E; 4436137N. 5215'. Peach-leaf willow on knoll beside prairie dog colony 50 m east of road. Prairie dog colony, mixed-grass prairie, emergent wetland.
3. 13T 0479374E; 4436355N. 5222'. Cottonwood on south edge of Little Dry Creek marsh halfway between North 51st Street and Lake Valley pond. Emergent wetland, riparian woodland, mixed-grass prairie, prairie dog colony.
4. 13T 0479585E; 4436448N. 5223'. Fencepost on northeast side of Little Dry Creek marsh 30 m west of bend in road. Emergent wetland, teasel, mixed-grass prairie.
5. 13T 0479844E; 4436435N. 5224'. Forked peach-leaf willow on north edge of Little Dry Creek cattail marsh 40 m south of road. Emergent wetland, mixed-grass prairie, riparian woodland.
6. 13T 0480409E; 4436590. 5205'. Cottonwood in dense cottonwood grove 30 m west of small inlet. Riparian woodland, emergent wetland, mixed-grass prairie, shoreline, open water.
7. 13T 0480398E; 4436903N. 5204'. Prominent fencepost on south side of marsh encircling inlet southeast of Anthill. Emergent wetland, mixed-grass prairie, shrubland, teasel, shoreline, open water.
8. 13T 0480144 E; 4436951N. 5224'. Metal fencepost at north end of the fence line on south side of drainage that passes south of Anthill. Mixed-grass prairie, willow carr, emergent wetland, riparian woodland, prairie dog colony.
9. 13T 0480384E; 4437305N. 5205'. Prominent pair of cottonwoods in grove northeast of cattail marsh. Mixed-grass prairie, emergent wetland, riparian woodland, barren ground.
10. 13T 048 0251E; 4437450N. 5209'. Rebar on south bank of Dry Creek 30 m east of road. Shrubland, emergent wetland, mixed-grass prairie, teasel.
11. 13T. 0480611E; 4437207N. 5184'. Sprawling willow on east bank of inlet. Willow carr, riparian woodland, shoreline, open water, emergent wetland, mixed-grass prairie.

12. 13T 0481500E; 4437305N. 5207'. West end of cottonwood grove on north shore of reservoir. Open water, shoreline, riparian woodland, barren ground, mixed-grass prairie.

13. 13T 0481602E; 4437489N. 5233'. Southeast end of cottonwood grove on small drainage branching off of feeder canal. Riparian woodland, emergent wetland, shrubland, mixed-grass prairie.

14. 13T 0481763E; 4437642N. 5222'. Great blue heron interpretive sign along trail on north side of Coot Lake marsh. Emergent wetland, riparian woodland, agricultural, barren ground, mixed-grass prairie.

15. 13 T 0481957E; 4437334N. 5223'. Large signpost along north side of trail near southeast corner of Coot Lake wetland. Emergent wetland, riparian woodland, barren ground, mixed-grass prairie.

16. 13 T 0482270E; 4437238N. 5251'. Bench 50 m wsw of Coot Lake parking area. Shoreline, non-native riparian woodland, barren ground, mixed-grass prairie.

17. 13T 0482214E; 4436728N. 5232'. Lone telephone pole in the largest drainage below east dam face. Mixed-grass prairie, emergent marsh, riparian woodland. Blue marker is on adjacent Russian olive.

18. 13T 0481812E; 4436085N. 5179'. Solitary post 10 m southeast of prominent gate about 30 m below southeast dam face. Mixed-grass prairie, barren ground, emergent wetland.

19. 13T 0481240E; 4435582N. 5235'. Small cottonwood grove at base of dam at east end of marina beach. Shoreline, open water, barren ground, riparian woodland.

20. 13T 0480260E; 443586. 5225'. Slightly isolated cottonwood 20 m south of shoreline in Dream Cove picnic area. Shoreline, barren ground, open water, riparian woodland.

Appendix III. Birds Seen or Heard within 1 km of Boulder Reservoir

Occurrence Codes:

Y: year-round resident S: summer resident M: migrant W: winter resident (underlining denotes confirmed breeder)

Habitat Codes

AEM: emergent wetland ASL: Shoreline CPL: croplands LRD: riparian woodland MSB: bridges MSP: poles OWL: open water

RRL: rural residential SLE: shrubland TNG: mixed-grass prairie TSG: shortgrass prairie WJJ: juniper woodland

Abundance Codes:

1: abundant 2: common 3: fairly common 4: uncommon 5: rare

Colorado Natural Heritage Program global ranking codes:

G3: vulnerable to extirpation or extinctio; G4: widespread, abundant, and apparently secure;

G5: demonstrably widespread, abundant and secure; T, rank applies to subspecies.

State Ranking Codes:

S1, state critically imperiled; S2, state imperiled; S3, state rare or uncommon; S4, state apparently secure; B, breeding

N, non-breeding populations.

Boulder County Nature Association birds of special concern codes:

1: Rare and declining. Three or fewer annually documented nesting sites within the county.

3: Rare

4: Isolated and restricted (limited breeding habitat).

6: Extirpated as a locally breeding species.

Common Name	Occurr.	Habitat	Abund.	CO Status	CNHP Rank	BCNA Status	Source
Ducks, Geese, and Swans							
Greater White-fronted Goose	M	OWL	5				BCAS
Snow Goose	M	OWL	4				BCAS
Ross's Goose	M	OWL	5				BCAS
Cackling Goose	W	OWL	3				BCAS
Canada Goose	<u>Y</u>	ASL, AEM, OWL	1				Jones 2013
Trumpeter Swan	W	ASL, OWL	5				BCAS
Tundra Swan	W	ASL, OWL	5				BCAS
Wood Duck	<u>Y</u>	ASL, OWS	3				Jones 2013
Gadwall	M	ASL, OWL	2				Jones 2013
American Wigeon	M	OWL	1				Jones 2013
Mallard	<u>Y</u>	ASL, AEM, OWL	1				Jones 2013
Blue-winged Teal	<u>S</u>	ASL, OWL	2				Jones 2013
Cinnamon Teal	S	AEM, OWL	2				Jones 2013
Northern Shoveler	Y	ASL, AEM, OWL	2				Jones 2013
Northern Pintail	M	OWL	3				Jones 2013
Green-winged Teal	<u>Y</u>	ASL, OWL	2				Jones 2013
Canvasback	M	OWL	3				BCAS
Redhead	M	OWL	1				Jones 2013
Ring-necked Duck	M	OWL	2				Jones 2013
Greater Scaup	M	OWL	4				Jones 2013
Lesser Scaup	M	OWL	3				Jones 2013
Surf Scoter	M	OWL	5				BCAS
White-winged Scoter	M	OWL	5				eBird
Black Scoter	M	OWL	5				BCAS
Long-tailed Duck	M	OWL	5				BCAS

Common Name	Occurr.	Habitat	Abund.	CO Status	CNHP Rank	BCNA Status	Source
Bufflehead	M	OWL	4				BCAS
Common Goldeneye	M	OWL	2				BCAS
Hooded Merganser	M	OWL	3				BCAS
Common Merganser	M	OWL	2				BCAS
Red-breasted Merganser	M	OWL	4				BCAS
Ruddy Duck	M	OWL	3				BCAS
Grouse, Turkeys, and Quail							
Northern Bobwhite	Y	LRD	5			1	Jones 2013
Chukar	Y	LRD	5				BCAS
Ring-necked Pheasant	Y	LRD	5				BCAS
Loons and Grebes							
Red-throated Loon	M	OWL	5				eBird
Pacific Loon	M	OWL	5				BCAS
Common Loon	M	OWL	4				BCAS
Pied-billed Grebe	Y	OWL	2				Jones 2013
Horned Grebe	M	OWL	3				BCAS
Eared Grebe	M	OWL	3			1	Jones 2013
Red-necked Grebe	M	OWL	5				BCAS
Western Grebe	Y	OWL	1				Jones 2013
Clark's Grebe	M	OWL	3				BCAS
Double-crested Cormorant	S	AEM, OWL	2				Jones 2011
American White Pelican	S	ASL, OWL	2		G3; S1B		Jones 2011
Brown Pelican	M	OWL	5				BCAS
Bitterns and Herons							
American Bittern	<u>S</u>	AEM	4			4	Jones 2013
Great Blue Heron	<u>Y</u>	AEM, ASL	1				Jones 2013
Great Egret	S	ASL	3			3, 4	Jones 2013
Snowy Egret	S	ASL	3		G5; S2B		BCAS
Cattle Egret	S	ASL	5				BCAS
Green Heron	S	AEM, ASL	5				BCAS
Black-crowned Night Heron	S	LRD	4				Jones 2012
Glossy Ibis	M	ASL	5				eBird
White-faced Ibis	M	ASL	3		G5; S2B		Jones 2013
New World Vultures							
Turkey Vulture	S	TMG	2				Jones 2013
Hawks and Eagles							
Osprey	<u>S</u>	MSP, ASL	2				Jones 2013
Bald Eagle	Y	LRD, ASL	3	ST	G5; S1B, S3N	4	Jones 2013
Northern Harrier	<u>Y</u>	AEM, TMG	3			1, 4	Jones 2013
Sharp-shinned Hawk	M	LRD	4				BCAS
Cooper's Hawk	Y	LRD	4				Jones 2013
Broad-winged Hawk	M	LRD	5				BCAS
Swainson's Hawk	<u>S</u>	LRD	3				Jones 2013

Common Name	Occurr.	Habitat	Abund.	CO Status	CNHP Rank	BCNA Status	Source
Red-tailed Hawk	<u>Y</u>	LRD, RRL	2				Jones 2013
Ferruginous Hawk	W	TMG	4	SC	G4; S3B, S4N		BCNA
Rough-legged Hawk	W	TMG	4				BCNA
Golden Eagle	Y	TMG	4				BCAS
Coot, Rails, and Crane							
Virginia Rail	Y	AEM	3				Jones 2012
Sora	S	AEM	3				Jones 2012
American Coot	<u>Y</u>	AEM, OWL	2				Jones 2013
Sandhill Crane	M	AEM	4	SC	G5T4;S2B,S4N		BCAS
Shorebirds							
Semipalmated Plover	M	ASL	4				BCAS
Killdeer	<u>Y</u>	ASL	1				Jones 2013
Mountain Plover	S	TSG	5	SC	G2;S2B	6	eBird
American Avocet	S	ASL	3				BCAS
Spotted Sandpiper	<u>S</u>	ASL	2				BCAS
Solitary Sandpiper	M	ASL	4				BCAS
Greater Yellowlegs	M	ASL	3				BCAS
Lesser Yellowlegs	M	ASL	3				BCAS
Willit	M	ASL	4		G5;S1B		BCAS
Whimbrel	M	ASL	5				Ebird
Long-billed Curlew	S	ASL	4	SC	G5; S2B	6	Jones 2013
Hudsonian Godwit	M	ASL	5				BCAS
Marbled Godwit	M	ASL	4				BCAS
Sanderling	M	ASL	4				eBird
Semipalmated Sandpiper	M	ASL	4				BCAS
Western Sandpiper	M	ASL	3				BCAS
Least Sandpiper	M	ASL	4				BCAS
Baird's Sandpiper	M	ASL	2				BCAS
Pectoral Sandpiper	M	ASL	5				BCAS
Still Sandpiper	M	ASL	5				BCAS
Ruff	M	ASL	5				eBird
Long-billed Dowitcher	M	ASL	4				BCAS
Wilson's Snipe	<u>Y</u>	AEM	2				Jones 2013
Wilson's Phalarope	S	AEM	3		G5;S4B,S4N		BCAS
Red-necked Phalarope	M	OWL	5				BCAS
Red Phalarope	M	OWL	5				BCAS
Long-tailed Jagger	M	OWL	5				BCAS
Gulls and Terns							
Sabine's Gull	M	ASL, OWL	5				BCAS
Bonaparte's Gull	M	ASL, OWL	4				BCAS
Franklin's Gull	M	ASL, OWL	2				Jones 2013
Mew Gull	M	OWL	5				BCAS
Ring-billed Gull	Y	ASL, OWL	1				Jones 2013
California Gull	S	ASL, OWL	3				BCAS
Herring Gull	W	ASL, OWL	3				BCAS

Common Name	Occurr.	Habitat	Abund.	CO Status	CNHP Rank	BCNA Status	Source
Thayer's Gull	M	ASL, OWL	4				BCAS
Slaty-backed Gull	M	ASL, OWL	5				BCAS
Caspian Tern	M	ASL, OWL	5				BCAS
Black Tern	M	OWL	3				BCAS
Common Tern	M	OWL	5				BCAS
Arctic Tern	M	OWL	5				BCAS
Forster's Tern	M	ASL, OWL	3		G5, S2B, S4N		BCAS
Doves and Cuckoos							
Rock Pigeon	<u>Y</u>	RRL	2				Jones 2013
Eurasian Collared-Dove	<u>Y</u>	RRL	1				Jones 2013
White-winged Dove	S	LRD, RRL	4				eBird
Mourning Dove	<u>S</u>	LRD	1				Jones 2013
Owls							
Barn Owl	<u>S</u>	RRL	4				Jones 2013
Great Horned Owl	<u>Y</u>	LRD, RRL	2				Jones 2013
Burrowing Owl	<u>S</u>	TSG	3	ST	G4, S4B	4	Jones 2013
Long-eared Owl	M	LRD, RRL	5				eBird
Short-eared Owl	W	AEM	5				BCAS
Nightjars and Swifts							
Common Nighthawk	S	TMG, LRD	3				Jones 2013
White-throated Swift	M	TMG	4				BCAS
Hummingbirds							
Broad-tailed Hummingbird	M	LRD, SLE	3				BCAS
Kingfisher							
Belted Kingfisher	Y	ASL	3				Jones 2013
Woodpeckers							
Lewis's Woodpecker	S	LRD	5			2	BCAS
Red-headed Woodpecker	<u>S</u>	LRD	5			2	Jones 2013
Downy Woodpecker	<u>Y</u>	LRD	2				Jones 2013
Hairy Woodpecker	Y	LRD	3				Jones 2013
Northern Flicker	<u>Y</u>	LRD	1				Jones 2013
Falcons							
American Kestrel	<u>Y</u>	LRD	2				Jones 2013
Merlin	M	LRD	4				BCNA
Peregrine Falcon	Y		4	SC	G4T4; S2B G5; S4B, S4N		BCAS
Prairie Falcon	Y	TMG	3				BCNA
Tyrant Flycatchers							
Western Wood-Pewee	M	LRD	3				Jones 2013
Say's Phoebe	S	TMG	3				Jones 2013
Western Kingbird	<u>S</u>	LRD	2				Jones 2013

Common Name	Occurr.	Habitat	Abund.	CO Status	CNHP Rank	BCNA Status	Source
Eastern Kingbird	<u>S</u>	LRD	2				Jones 2013
Shrikes							
Loggerhead Shrike	S	TSG, WJJ	4			1, 4	BCAS
Northern Shrike	W	TMG	4				BCAS
Vireos							
Warbling Vireo	S	LRD	2				BCAS
Red-eyed Vireo	M	LRD	5				eBird
Jays and Crows							
Blue Jay	<u>Y</u>	LRD	3				Jones 2013
Black-billed Magpie	<u>Y</u>	LRD	2				Jones 2013
American Crow	Y	LRD	2				Jones 2013
Common Raven	Y	LRD, TMG	3				Jones 2013
Larks							
Horned Lark	Y	TSG	3				Jones 2013
Swallows							
Tree Swallow	S	OWL, AEM	2				BCAS
Violet-green Swallow	S	OWL, AEM	2				BCAS
N. Rough-winged Swallow	S	TSG, AEM, OWL	2				BCAS
Bank Swallow	S	ASL, OWL	4				BCAS
Cliff Swallow	<u>S</u>	MSB, RRL	1				BCAS
Barn Swallow	<u>S</u>	MSB, RRL	2				BCAS
Chickadees and Titmice							
Black-capped Chickadee	Y	LRD	2				Jones 2013
Mountain Chickadee	Y	WJJ	3				Jones 2013
Nuthatches							
White-breasted Nuthatch	Y	LRD	3				BCAS
Pygmy Nuthatch	M	WJJ	5				BCAS
Brown Creeper	Y	LRD	3				BCAS
Wrens and Gnatcatcher							
Rock Wren	S	ASL, MCL	4				BCAS
House Wren	S	LRD	3				Jones 2012
Sedge Wren	M	AEM	5				BCAS
Marsh Wren	S	AEM	4				Jones 2012
Blue-gray Gnatcatcher	M	LRD, WJJ	4				BCAS
Kinglets							
Ruby-crowned Kinglet	M	LRD, WJJ	3				BCAS
Thrushes							
Eastern Bluebird	M	LRD	4				BCAS
Western Bluebird	M	TMG	3				BCAS

Common Name	Occurr.	Habitat	Abund.	CO Status	CNHP Rank	BCNA Status	Source
Mountain Bluebird	S	TMG	3				Jones 2013
Townsend's Solitaire	W	LRD	3				BCAS
Hermit Thrush	M	LRD	4				eBird
American Robin	<u>Y</u>	LRD, RRL	1				Jones 2013
Gray Catbird	S	SLE	4				
Northern Mockingbird	S	LRD	5				BCAS
Thrashers							
Sage Thrasher	M	SLE	4				BCAS
Starlings							
European Starling	<u>Y</u>	LRD, RRL	1				Jones 2013
Pipits							
American Pipit	M	ASL, TMG	3				BCAS
Waxwings							
Cedar Waxwing	M	LRD	4				Jones 2013
Longspurs							
Chestnut-collared Longspur	M	TSG	5				eBird
Wood-Warblers							
Orange-crowned Warbler	M	AEM, LRD	3				BCAS
McGillivray's Warbler	M	AEM	3				eBird
Common Yellowthroat	<u>S</u>	AEM	2				
Blackburnian Warbler	M	LRD	5				Jones 2013
Yellow Warbler	<u>S</u>	LRD	1				Jones 2012
Yellow-rumped Warbler	M	LRD	1				Jones 2013
Townsend's Warbler	M	LRD, WJJ	4				BCAS
Wilson's Warbler	M	LRD/SLE	3				BCAS
Towhees							
Green-tailed Towhee	M	SLE	3				BCAS
Spotted Towhee	S	SLE	3				Jones 2013
Sparrows							
American Tree Sparrow	M	LRD, TMG	1				Jones 2013
Chipping Sparrow	S	LRD, RRL, WJJ	2				Jones 2013
Clay-colored Sparrow	M	TMG	3				BCAS
Brewer's Sparrow	M	TMG	3				BCAS
Vesper Sparrow	<u>S</u>	TMG	2				BCAS
Lark Sparrow	S	TMG	3				BCAS
Sage Sparrow	M	TMG, SLE	5				BCAS
Lark Bunting	S	TMG	4				BCAS
Savannah Sparrow	S	AEM, TMG	4				BCAS
Grasshopper Sparrow	S	TMG	3			4	BCAS
LeConte's Sparrow	M	TMG	5				BCAS
Song Sparrow	<u>Y</u>	AEM	2				Jones 2013

Common Name	Occurr.	Habitat	Abund.	CO Status	CNHP Rank	BCNA Status	Source
Lincoln's Sparrow	M	AEM	3				BCAS
White-crowned Sparrow	M	SLE	3				Jones 2013
Dark-eyed Junco	M	LRD, TMG, WJJ	2				Jones 2013
Tanager, Grosbeaks, Dickcissel							
Western Tanager	M	LRD	3				BCAS
Rose-breasted Grosbeak	M	LRD	5				
Black-headed Grosbeak	S	LRD	3				BCAS
Blue Grosbeak	<u>S</u>	LRD, SLE	2				Jones 2012
Lazuli Bunting	M	SLE	4				BCAS
Dickcissel	S	AEM, CPL	4				Jones 2012
Blackbirds							
Bobolink	S	AEM, CPL	4		G5;S3B	4	BCAS
Red-winged Blackbird	<u>Y</u>	AEM, ASL	1				Jones 2013
Western Meadowlark	<u>Y</u>	TMG	1				Jones 2013
Yellow-headed Blackbird	S	AEM	2				Jones 2013
Brewer's Blackbird	<u>Y</u>	LRD	3				Jones 2012
Common Grackle	<u>S</u>	LRD, RRL	1				Jones 2013
Great-tailed Grackle	S	AEM	3				BCAS
Brown-headed Cowbird	S	LRD, RRL	1				Jones 2013
Orioles							
Orchard Oriole	S	LRD	5				Jones 2013
Bullock's Oriole	<u>S</u>	LRD	2				Jones 2012
Finches							
House Finch	<u>Y</u>	LRD, RRL	2				Jones 2013
Pine Siskin	M	LRD, WJJ	3				BCAS
Common Redpoll	M	TMG	4				eBird
Lesser Goldfinch	S	LRD	2				Jones 2013
American Goldfinch	<u>Y</u>	LRD, RRL	1				Jones 2013
Weaver Finches							
House Sparrow	<u>Y</u>	RRL	2				Jones 2013

Sources:

BCAS: Boulder County Audubon Society. 1979-2013. Monthly Wildlife Inventories.

Jones, Stephen R. 2013. Boulder Reservoir 2013 bird study. Unpublished report for Boulder County Parks and Recreation Department.

Jones, Stephen R. 2012. Birds of special concern Boulder Reservoir 2012 monitoring summary. Unpublished report for Boulder County Parks and Recreation Department.

eBird. <http://ebird.org/content/ebird/>

Appendix IV: Point Count Results

Table 1. Breeding season (June-July) point-count results, points 1-10. Mean number per survey.

Species	1	2	3	4	5	6	7	8	9	10
Canada Goose	2.7	6.0					8.3	0.3	0.3	
Gadwall							3.7		0.7	
Mallard	1.3	15.3				1.7			1.0	
Blue-winged Teal										
Double-crested Cormorant					0.7					
American White Pelican		0.3								
American Bittern									0.3	
Osprey					0.7		1.0			
Killdeer	0.3	1.0		0.3	0.7	1.0			1.3	0.7
Spotted Sandpiper						1.0				0.3
Wilson's Snipe		0.7		1.3	1.3					
Ring-billed Gull						0.3				
Sora			0.3	0.3						
Eurasian Collared-Dove					0.3		0.3			
Mourning Dove	2.0	0.7	0.3	3.0	1.0	0.3	0.3		1.3	0.7
Broad-tailed Hummingbird	0.3						0.3			
Belted Kingfisher										
Northern Flicker										
Western Wood-Pewee								0.3		
Western Kingbird					1.0			0.7	1.3	0.7
Eastern Kingbird		0.7		0.3		0.3	0.3			
Black-billed Magpie			0.3		0.7					0.3
Tree Swallow		0.3							0.3	0.3
Cliff Swallow	2.7	2.0	1.3	2.0	3.0	5.3	3.3	2.7	3.7	3.7
Barn Swallow	0.3	1.3	0.7		0.7					
American Robin		1.0		0.3			0.3		0.7	
European Starling	0.3	1.3						2.7		
Common Yellowthroat	1.3	0.3	1.3	2.3	1.7		1.0	2.0	1.7	1.3
Yellow Warbler	1.0	0.7	0.7		1.0		1.0		1.0	
Yellow-rumped Warbler				0.3				1.0	0.7	
Vesper Sparrow						0.3				
Song Sparrow	0.7		0.3		0.3		1.0		0.7	
Sparrow species								0.3		
Blue Grosbeak				0.3				1.3		0.3
Dickcissel								0.3		
Red-winged Blackbird	11.3	3.7	7.0	4.7	10.0	1.7	6.3	6.7	12.0	6.7
Western Meadowlark	0.7	2.7	1.7	1.7	1.3	1.0	1.7	2.0	1.0	1.0
Yellow-headed Blackbird		0.7								
Brewer's Blackbird		0.7						0.3		0.7
Common Grackle	4.0	0.3	0.3			0.3			0.7	0.3
Brown-headed Cowbird	0.7		1.7	0.7				1.7	1.0	

Orchard Oriole										
Bullock's Oriole			1.0		0.7		0.7		0.3	0.3
House Finch										0.3
American Goldfinch		0.3	1.3	0.3		1.0	0.3	2.0	1.0	
Passerine species			0.3	0.3				0.3		
Mean species	10.7	11.0	8.7	8.0	9.7	5.7	10.3	9.3	10.3	7.3
Mean individuals	29.7	40.0	18.7	18.3	25.0	14.3	30.0	24.7	31.0	17.7

Table 1b. Breeding season (June-July) point-count results, points 1-10. Mean number per survey.

Species	11	12	13	14	15	16	17	18	19	20	Total
Canada Goose	0.7									34.0	52.3
Wood Duck					0.3						0.3
Gadwall	0.7										5.0
Mallard	4.3										23.7
Blue-winged Teal	1.7										1.7
Cinnamon Teal	0.3										0.3
Redhead	1.0										1.0
Northern Bobwhite									0.3		0.3
Clark's Grebe					0.3						0.3
Western Grebe										0.3	0.3
Double-crested Cormorant											0.7
American White Pelican										0.3	0.7
American Bittern					0.3						0.7
Osprey											1.7
Killdeer	1.7				0.3	1.0	0.7	0.7		0.3	10.3
Spotted Sandpiper					0.3					0.3	2.0
American Avocet	0.7										0.7
Wilson's Snipe							0.3				3.7
Ring-billed Gull											0.3
Sora							0.3				1.0
Eurasian Collared-Dove						0.7			0.3	0.3	2.0
Mourning Dove	0.7	0.3	0.7	2.7	0.3	0.3	0.7	0.7	1.0	1.0	18.0
Broad-tailed Hummingbird											0.7
Belted Kingfisher		0.3		0.3	0.3				0.3		1.3
Northern Flicker						0.3		0.3		0.3	1.0
Western Wood-Pewee											0.3
Western Kingbird				0.3		1.3	0.7	0.3	0.3		6.7
Eastern Kingbird	0.3		0.3	0.3						0.3	3.0
Black-billed Magpie											1.3
Tree Swallow										0.3	1.3
Cliff Swallow	3.7	4.7	8.0	1.7	4.0	1.3	14.7	9.7	6.0	2.7	86.0
Barn Swallow	1.0			0.3						0.3	4.7
Black-capped Chickadee									0.3		0.3
American Robin		0.3	1.3	1.0	1.3	1.0			1.0	2.3	9.7
Gray Catbird			0.3								0.3

European Starling							0.7		1.3		6.3
Common Yellowthroat	0.7		0.7	2.0	2.0		0.7				19.0
Yellow Warbler	1.3	1.0	1.7	2.7	2.0	0.7				0.7	15.3
Yellow-rumped Warbler											2.0
Vesper Sparrow							1.0	1.0	0.3		2.7
Song Sparrow	1.0		0.3	2.0	1.0						7.3
Sparrow species											0.3
Blue Grosbeak	0.7		1.7	0.3	0.3		0.7	0.3	0.7		6.7
Dickcissel				1.0							1.3
Red-winged Blackbird	4.7	4.3	4.3	7.7	5.7	0.3	3.7	0.3	0.3	1.7	103.0
Western Meadowlark	2.0	0.7	2.0	0.3	1.3	0.7	2.3	2.3	0.7	1.3	28.3
Yellow-headed Blackbird											0.7
Brewer's Blackbird	0.7	5.0		1.3						2.3	11.0
Common Grackle		1.7		0.3	0.3	2.0		0.3	2.0	3.0	15.7
Brown-headed Cowbird	1.7		0.7		1.0		1.3	0.3	0.7	0.3	11.7
Blackbird species						1.0					1.0
Orchard Oriole	0.3										0.3
Bullock's Oriole	0.7		0.3	0.3		2.0	0.3			0.3	7.0
House Finch			1.3					0.7	2.3		4.3
Lesser Goldfinch			0.7	0.7							1.3
American Goldfinch	0.7	0.3	2.3	2.3	1.0	1.7			0.3	0.7	15.7
Passerine species						0.7					1.3
Mean species	12.0	5.3	9.3	10.3	10.0	8.0	8.0	6.0	8.3	11.7	
Mean individuals	31.0	18.7	26.7	27.7	22.3	15.0	28.0	17.0	18.3	53.3	

Table 2a. Spring migration (April-May) point-count survey results, points 1-10. Mean number per survey.

Species	1	2	3	4	5	6	7	8	9	10
Canada Goose	1.5	1.5								
Gadwall		1.5				0.5				
American Wigeon							1.5			
Mallard	1.0		0.5		1.0					
Northern Shoveler							0.5			
Northern Pintail							0.5			
Green-winged Teal							0.5			
Western Grebe						0.5	0.5			
American White Pelican							2.5			
Great Blue Heron								0.5		
White-faced Ibis							9.0			
Osprey					1.0					
American Kestrel						0.5				
Killdeer		0.5	0.5			0.5	0.5			0.5
Spotted Sandpiper						2.0				
Lesser Yellowlegs							2.0			
Wilson's Snipe			0.5						0.5	3.5
Ring-billed Gull							0.5			0.5
Virginia			0.5							
Eurasian Collared-Dove	0.5	0.5								
Mourning Dove	1.5		0.5	1.5	0.5		0.5			
Belted Kingfisher										
Northern Flicker			0.5				0.5	0.5		0.5
Western Kingbird					0.5					
Eastern Kingbird							0.5			
Black-billed Magpie		0.5	0.5	1.0				0.5		
Black-capped Chickadee	0.5									
American Robin	0.5	0.5								
European Starling	1.5								0.5	
Yellow Warbler			0.5				0.5			
Yellow-rumped Warbler				0.5		1.5			0.5	
Common Yellowthroat			0.5	1.0	0.5		1.0	0.5		
Vesper Sparrow						0.5			0.5	
Song Sparrow					0.5		0.5	1.5		
Dickcissel										
Red-winged Blackbird	11.0	3.5	10.0	10.0	12.0	0.5	5.5	10.0	9.5	9.5
Western Meadowlark	2.5	3.0	0.5	1.0	1.0	0.5	1.5	1.5	2.0	1.5
Brewer's Blackbird								0.5		
Brown-headed Cowbird			0.5	0.5					0.5	
Bullock's Oriole	0.5	0.5			0.5		0.5			0.5
American Goldfinch	1.5			0.5		0.5	0.5		0.5	
Mean species	8.0	5.5	6.5	5.5	5.0	5.0	11.0	5.0	5.0	4.5
Mean individuals	22.5	12.0	15.5	16.0	17.5	7.5	29.5	15.5	14.5	16.5

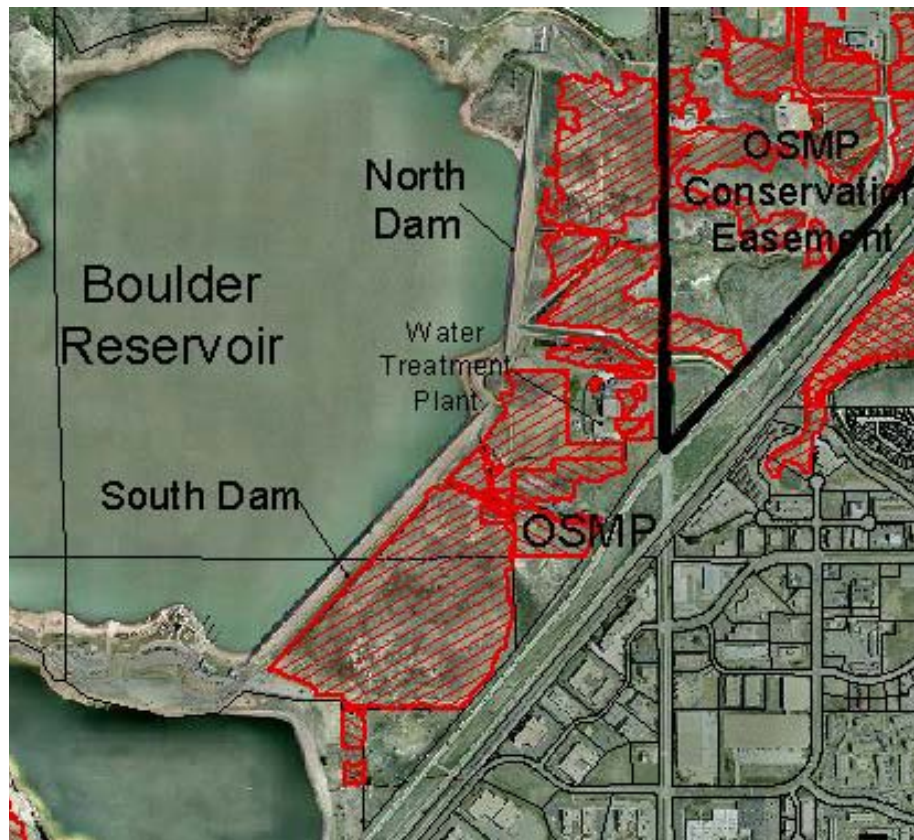
Table 2b. Spring migration (April-May) point-count survey results, points 11-20. Mean number per survey.

Species	11	12	13	14	15	16	17	18	19	20	Total
Canada Goose					1.0	1.0	1.0			1.0	7.0
Gadwall											2.0
American Wigeon											1.5
Mallard	0.5	1.0		2.0				1.0		3.0	9.0
Northern Shoveler											0.5
Northern Pintail											0.5
Green-winged Teal											0.5
Common Merganser										1.5	1.5
Western Grebe		2.5									1.0
American White Pelican	2.0										4.5
Great Blue Heron					0.5				0.5		1.5
White-faced Ibis											9.0
Osprey											1.0
American Kestrel											0.5
Killdeer	1.0					0.5	1.5	1.0			7.0
American Avocet	5.5										5.5
Spotted Sandpiper	1.0	1.0								0.5	4.5
Lesser Yellowlegs	1.5										3.5
Wilson's Snipe											4.5
Ring-billed Gull	2.0										3.0
Virginia											0.5
Eurasian Collared-Dove						0.5			0.5		2.0
Mourning Dove	1.0			2.0	2.5	1.0				1.0	12.0
Belted Kingfisher			0.5	0.5							1.0
Northern Flicker					1.0						3.0
Western Kingbird						1.0					1.5
Eastern Kingbird			1.5								2.0
Loggerhead Shrike					0.5		0.5				1.0
Blue Jay										0.5	0.5
Black-billed Magpie			1.0							1.0	4.5
Tree Swallow							2.5				2.5
Rough-winged Swallow		0.5									0.5
Barn Swallow		6.0					4.5				10.5
Black-capped Chickadee										1.0	1.5
House Wren			0.5								0.5
American Robin			2.0	2.5	1.5	1.0	10.5	0.5	1.5	1.5	21.5
European Starling			2.0						0.5		4.0
Yellow Warbler	0.5		0.5	0.5	1.0	0.5					4.0
Yellow-rumped Warbler	2.5									0.5	5.5
Blackburnian Warbler	0.5										0.5
Common Yellowthroat			1.0	0.5							5.0
Green-tailed Towhee				1.0							1.0
Chipping Sparrow				1.0				0.5			1.5
Vesper Sparrow								1.5	0.5		3.0

Species	11	12	13	14	15	16	17	18	19	20	Total
Grasshopper Sparrow				1.0							1.0
Song Sparrow			0.5	1.0	0.5						4.5
Sparrow species					0.5						0.5
Red-winged Blackbird	9.5		3.5	8.0	8.0	0.5	4.5	0.5	2.5	2.5	121.0
Western Meadowlark	1.5	1.0	2.5	0.5	1.0	1.5	1.0	1.5	0.5	1.0	27.0
Brewer's Blackbird											0.5
Common Grackle							1.0			2.0	3.0
Brown-headed Cowbird					2.0		2.0				5.5
Bullock's Oriole						0.5					3.0
House Finch						0.5			2.0		2.5
American Goldfinch	0.5		1.0	1.5	0.5	6.5				1.0	14.5
Mean species	9.0	3.0	7.5	8.0	8.0	7.5	6.5	4.0	5.0	9.0	
Mean individuals	29.5	12.0	15.5	22.0	20.5	15.0	29.0	6.5	8.5	18.0	

APPENDIX D
EXISTING PRAIRIE DOG INFORMATION

Colony #1b Boulder Reservoir Dams



COLONY DESCRIPTION

Colony is approximately 134 acres:

- Open Space & Mtn Parks = 22 acres
- Parks & Recreation = 120 acres

Condition of Colony:

- Colonies are dense (approximately 20/acre per P&R counts)
- Area is highly visible from major roadway and recreational visitors
- Vegetation is mostly non-native and invasive on dam face
- Vegetation trending toward non-native and invasive in other areas
- Area is part of a larger prairie dog habitat conservation area
- Documented and currently protected burrowing owl nest site(s)
- This area is also significant habitat for other wintering raptors
- Colonies seem to have been resistant to plague events that have occurred in contiguous landscapes in the last 30 years and the area is currently part of ongoing plague research
- Buffer areas immediately east of each of the dam faces are currently managed as prairie dog removal under an agreement with Northern Colorado Water Conservancy District to protect the integrity of the dams

MANAGEMENT CLASSIFICATIONS/ACTION PLAN

Open Space and Mountain Parks:

Classification-Long Term Protection

Parks and Recreation:

Classification- Long Term Protection

Classification-Near Term Removal from 100-200 feet at base of dams/buffer areas under Agreement with Colorado Northern Water Conservancy District to protect dam safety and planned development near of Fire Training Center, south dam

Cost:

- Removal through fumigation-approximately \$5,000 annually
- Barrier maintenance-approximately \$5,000 annually, does not include periodic capital improvement costs

ANALYSIS FOR MANAGEMENT CLASSIFICTIONS/ACTION PLAN

Current Land Use/Zoning Designations of Properties

- Designated a Habitat Conservation Area in OSMP HCP
- Designated as a Habitat Protection Area in the Boulder Reservoir Area Management Plan
- Drinking water containment
- Passive recreation
- Boulder Valley Comprehensive Plan natural ecosystem designation

Colony Conditions

This colony complex is among the largest in the service area. The area is expansive and active. Colonies are densely populated, annual counts estimate density averaging about 20 animals per acre. Vegetative cover is approximately 60%, predominately non-native and invasive species. This area is documented habitat for burrowing owls and is significant habitat for wintering raptors. As noted in our annual counts and recent comprehensive report of count data since 1998, this area is important to a variety of vertebrates, including several Colorado threatened Species and Species of Concern. The prairie dog colonies that have been monitored appear to be stable.

Landscape Context

The colonies at this site exist in a highly modified landscape that is dominated by human uses-hiking, biking, dog walking, running, horse back riding and large scale athletic/public events. The colony complex is located near an area with large bodies of open water (Six Mile Reservoir, Boulder Reservoir, Coot Lake), wetlands, prairie dog habitat conservation areas as well as grasslands undisturbed by prairie dogs. It is likely that some predators occur in this area.

Ownership

The land at this site is owned by the city of Boulder. Approximately 120 acres of this complex is managed by the Parks and Recreation Department and approximately 22 acres is managed by the Open Space and Mountain Parks Department. The buffer area, east of each the dam face, is managed under a cooperative agreement between the city and the Northern Colorado Water Conservancy District. The buffer areas are actively managed to prevent prairie dog occupation to protect the integrity of the dams.

Nature and Level of Conflicts

Areas classified as **Near Term Removal Areas** in this colony report, are areas where the presence or activities of prairie dogs are in direct conflict with public services/ facilities and public safety. The primary conflict at this site has been maintaining the “prairie dog free” buffer areas adjacent to the dam faces. The city continues to work with the Northern Colorado Water Conservancy District to protect public safety and drinking water storage capabilities at the Reservoir, by managing the buffer areas of the dams through active removal, barrier construction and maintenance. A conflict that will need to be managed in the future is the construction and development of the new Fire Training Center that will be located at the south end of the south dam on active prairie dog habitat. Other areas of potential conflict are with adjacent landowners that may be impacted by the expansion of the colonies and/or public health issues associated with the potential exposure to plague.

BLACK-TAILED PRAIRIE DOG AND ASSOCIATES

Conservation Target: Black-Tailed Prairie Dog and Associates

Category: Landscape Context

Key Attribute: Prairie Dog Distribution

Key attribute comment: In addition to being a native denizen of OSMP grasslands, prairie dogs create local habitats for a wide variety of species by virtue of their extensive burrowing and vegetation clipping. Because of their localized abundance, black-tailed prairie dogs are also important prey items for mid- and large-bodied grassland predators. OSMP seeks to maintain prairie dog complexes as part of the grassland ecosystem. The exact extent of prairie dog activity or the number of prairie dogs required for long-term sustainability is unknown. Although local populations have demonstrated resilience to population declines, at some level too few prairie dog colonies, or too few prairie dogs, could mean there are insufficient numbers to provide ecological function or survive a localized outbreak of disease or other cause of mortality. The effects of past land use and fragmentation in the Grassland Planning Area means that prairie dog habitat has been disturbed and that there are not unlimited opportunities for colony growth and prairie dog emigration. OSMP must also consider upper limits on the extent of prairie dog colonies to ensure conservation of other Grassland Plan targets (ESCO 2007).

OSMP staff believes that it is necessary to establish areas where prairie dog conservation is a management focus while minimizing conflict with other grassland plan targets. Ideally, these areas [Grassland Preserves, Multiple Objective Areas (MOA), and Prairie Dog Conservation Areas (PCA)] would include patches of prairie dog colonies within a matrix of uncolonized grassland habitat (Lomolino and Smith 2003). The areas would not be fully occupied. Long-term and complete occupation of Grassland Preserves, Multiple Objective Areas and Prairie Dog Conservation Areas by prairie dogs will provide fewer opportunities for colony expansion, results in decrease of native grass vigor and persistence, and confers less protection from stochastic events such as disease (plague) outbreaks (Cully and Williams 2001, Lomolino and Smith 2003, Collinge et al. 2005). OSMP seeks to have most of its prairie dog colonies in areas appropriate for prairie dog occupation and thus categorized as either Grassland Preserve, MOA or PCA.

Indicator: Percent of occupied land in Grassland Preserves, Multiple Objective Areas or Prairie Dog Conservation Areas

Indicator Ratings:

Poor: <50%

Fair: 50-70%

Good: >70-85%

Very Good: >85%

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 10/15/2007

Current Indicator Measurement: 0.75

Current Rating: Good

Current rating comment: Current rating is based on the 2008 prairie dog mapping.

Confidence of the current rating: High

Desired Rating: Good

Desired rating comment: OSMP staff wishes to preserve black-tailed prairie dogs, the ecosystem they help create, and the matrix habitat unoccupied by prairie dogs that allows for expansion and contraction of colonies within each habitat block designated as a Grassland Preserve, MOA, or PCA.

Other comments: OSMP staff wishes to preserve black-tailed prairie dogs, the ecosystem they help create and the matrix habitat unoccupied by prairie dogs that allows for expansion and contraction of colonies within each habitat block designated as a Grassland Preserve, MOA or PCA.

Conservation Target: Black-Tailed Prairie Dog and Associates

Category: Landscape Context

Key Attribute: Prairie Dog Occupancy

Key attribute comment: OSMP staff believes that it is necessary to establish areas where prairie dog conservation is a management focus. These grassland preserves should not necessarily always be fully occupied but rather prairie dogs should occupy a portion of those areas – patches of prairie dog colonies in a matrix of uncolonized grassland habitat (Lomolino and Smith 2003). Full (100%) occupation of prairie dog conservation areas would not create a sustainable metapopulation where colonies naturally expand, contract and die-out based on population growth, resource availability, predation and disease, and where inter-colony prairie dog dispersal maintains genetic diversity within the metapopulation (Roach et al. 2001, Stapp et al. 2004). Furthermore, fully occupied conservation areas confer less protection from stochastic events such as disease (plague) outbreaks (Cully and Williams 2001, Lomolino and Smith 2003, Collinge et al. 2005). Large areas of grassland, completely occupied by prairie dogs, would limit OSMP's ability to conserve several other targets, which are incompatible with prairie dogs (ESCO 2007). Therefore, it will be important to manage for areas unaffected by prairie dogs as well.

Indicator: Grassland preserves with occupancy between 10 and 26%

Indicator Ratings:

Poor: No grassland preserves within ARV

Fair: At least one grassland preserve outside the ARV

Good: All grassland preserves within the ARV

Indicator ratings comment: Indicator ratings were determined using historic mapping of prairie dog colonies and the creation of "habitat blocks" or grassland preserves across the GPA. Grassland preserves are relatively large areas of OSMP land with continuous suitable and unsuitable habitat separated by barriers to prairie dog movement and colony expansion such as highways and major waterways (Johnson and Collinge 2004, Collinge et al. 2005).

Occupancy of 10-26% in a grassland preserve, regardless of suitability, was determined to be the range of habitat block occupancy where there were large blocks of habitat for a large prairie dog metapopulation - and for other grassland targets that needed habitat unaffected by prairie dogs - to persist over the long term (Johnson 2002). We chose the desired range to reflect patches that had sufficient 1) space for colonies to expand, 2) distance between colonies and 3) areas of unoccupied habitat.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Current Indicator Measurement: Two of three grassland preserves outside of ARV

Current Rating: Fair

Current rating comment: Current indicator status was determined by evaluating 2008 colony extents of prairie dogs in each habitat block and calculating percentage occupancy in each habitat block. Large shifts in prairie dog populations during and following plague epizootics are likely to make this indicator dynamic over time, sometimes requiring frequent re-assessment as conditions change.

Confidence of the current rating: High

Desired Rating: Good

Other comments: It may be difficult to manage some areas for intermediate levels of prairie dog occupancy.

Conservation Target: Black-Tailed Prairie Dog and Associates

Category: Condition

Key Attribute: Animal Species Composition

Key attribute comment: The conservation objectives for this target include, but are not limited to black-tailed prairie dogs. OSMP also seeks to conserve two groups of animals that rely upon black-tailed prairie dogs and the conditions they create--commensals and predators. While prairie dogs colonies without these species contribute to the Grassland Plan's conservation objectives, OSMP staff considers the presence of commensals and predators an indication of greater ecological function.

The black-tailed prairie dog commensal species identified for this plan are:

Burrowing owl*
Deer mice
Tiger salamander
Cottontail rabbit
13-lined ground squirrel
Prairie tiger beetle*
Horned lark

*Sensitive commensal

These species are grassland obligates, benefit from the presence of prairie dogs and are not known to affect prairie dogs adversely. They are found more commonly on prairie dog colonies than on grasslands unaffected by prairie dogs (Koford 1958, Agnew et al. 1986, Haug et al. 1993, Desmond and Savidge 1996, Goodrich and Buskirk 1998, Kotliar et al. 1999, Kretzer and Cully 2001, Smith and Lomolino 2004).

Burrowing owls have experienced large global population declines. DeSante and George (1994) estimate population declines over fifty percent in British Columbia, Alberta, California, Nevada, Colorado and New Mexico. Populations have not been increasing in western states or provinces (James and Espie 1997). The species is listed as a state threatened species in Colorado. Populations have been undergoing non-cyclical declines over the past several decades in Boulder County, and the species is listed as a species of special concern in the Boulder County Comprehensive Plan. The Boulder Valley Comprehensive Plan identifies burrowing owls as a species of local concern. OSMP has identified burrowing owls as a species of concern.

Unoccupied prairie dog burrows are used as nests and refugia for breeding burrowing owls. The presence of burrowing owls is an indication of sufficient prey availability (Desmond et al. 2000). Burrowing owls are known to feed on smaller rodents and insects associated with prairie dog colonies (Haug et al. 1993). The presence of burrowing owls is an indication of an active trophic system reliant upon environmental conditions created by prairie dogs. Breeding success (≥ 1 fledgling per nesting attempt) by burrowing owls is evidence of not only the availability of nesting opportunities but also of habitat that can sustain the reproduction of this sensitive commensal species (Plumpton 1992, Haug et al. 1993).

OSMP staff believe habitat that supports nesting burrowing owls provides a higher level of ecological function than prairie dog colonies where burrowing owls are absent. Burrowing owl nesting success is a direct measure of site quality and function because breeding is the most energetically expensive time in the burrowing owl's life cycle. A successful nesting attempt on a prairie dog colony on OSMP requires sufficient prey, nest site availability and relatively low levels of human disturbance. These habitat characteristics can not be inferred by the presence of individuals during the breeding season because those owls may be passing through rather than nesting. Furthermore, successful nesting locations may

indicate long-term commitment by burrowing owls to an area. Burrowing owls are short-distant migrants and they tend to re-use nest sites where brood rearing was successful in the past (Haug et al. 1993).

Indicator: Number of prairie dog colonies with successful nesting attempts by burrowing owls

Indicator Ratings:

Poor: 0 prairie dog colonies surveyed have successful burrowing owl nesting attempts.

Fair: 1-2 prairie dog colonies surveyed have successful burrowing owl nesting attempts.

Good: 3-4 prairie dog colonies surveyed have successful burrowing owl nesting attempts.

Very Good: >4 prairie dog colonies surveyed have successful burrowing owl nesting attempts.

Indicator ratings comment: Burrowing owl presence or nesting success has not been systematically monitored on OSMP prairie dog colonies. Successful nesting occurred on OSMP lands during the 2008 breeding season. Staff combined knowledge from incidental sightings with habitat quality assessment to set indicator ratings for breeding burrowing owls.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 7/15/2008

Current Indicator Measurement: 4

Current Rating: Good

Current rating comment: Prior to 2008, burrowing owl presence was not systematically monitored. Recent observations have been largely anecdotal with no established protocol. With the release of an updated burrowing owl survey protocol by Colorado Division of Wildlife (2008) and recent publications confirming the efficacy of this protocol, staff began to conduct burrowing owl surveys in summer 2008.

Confidence of the current rating: Medium

Desired Rating: Good

Desired rating comment: The conservation objective for this indicator is to have at least three nesting pairs annually. That level of productivity has not been documented on OSMP lands in the past. However, our surveying efforts have been limited. The desired rating is based upon the availability of large areas of apparently suitable burrowing owl habitat.

Conservation Target: Black-Tailed Prairie Dog and Associates

Category: Condition

Key Attribute: Animal Species Composition

Key attribute comment: The conservation objectives for this target include, but are not limited to black-tailed prairie dogs. OSMP also seeks to conserve two groups of animals related to black-tailed prairie dogs, commensals and predators. Prairie dogs colonies without these species contribute to the Grassland Plan's conservation objectives but OSMP considers the presence of these species to be an indication of greater ecological function.

The black-tailed prairie dog commensal species identified for this plan are:

Burrowing owl*

Deer mice

Tiger salamander

Cottontail rabbit

13-lined ground squirrel

Prairie tiger beetle*

Horned lark

*Sensitive commensal

These species are grassland obligates which benefit from the presence of prairie dogs and are not known to affect prairie dogs adversely. They are found more commonly on prairie dog colonies than on grasslands unaffected by prairie dogs (Koford 1958, Agnew et al. 1986, Haug et al. 1993, Desmond and Savidge 1996, Goodrich and Buskirk 1998, Kotliar et al. 1999, Kretzer and Cully 2001, Smith and Lomolino 2004).

Breeding horned larks prefer short, sparsely vegetated areas—a situation commonly associated with occupied or recently abandoned prairie dog towns. The presence of horned larks is an indication of appropriate habitat conditions including prey availability. Horned larks are known to feed upon seeds and ground insects. The presence of horned larks is an indication of an active trophic system reliant upon environmental conditions created and maintained by prairie dogs. As a result, OSMP believes that habitat that supports horned larks provides a higher level of ecological function than prairie dog colonies where horned larks are absent.

Indicator: Percent of colonies with territorial horned larks

Indicator Ratings:

Poor: <25%

Fair: 25-50%

Good: >50-75%

Very Good: >75%

Indicator ratings comment: Territorial and nesting behaviors indicate that the individual has selected the habitat as appropriate, and potentially of sufficient quality to attract a mate (Krebs and Davies 1993). They are also direct measures of breeding attempts. Simple observation of horned larks is less useful because they may merely reflect the presence of migrant individuals.

We used average horned larks nesting territory size (~1.5 ha) from Dinkins et al. (2003) to determine how many prairie dog towns would qualify as potential breeding sites. Staff estimated the "Good"/"Fair" threshold at 50% using this information and observations from recent surveying efforts. Staff then used best professional judgment to assign other ratings. OSMP sought to acknowledge the importance of having populations of horned larks distributed throughout across the land system. It is understood by staff that some prairie dog colonies may carry more than a single pair of horned larks. Others, because of local conditions or size, may support none.

This indicator is proposed to be an average of values collected over a three year period. This approach will reduce the influence of annual variation of abundance and distribution due to detection probability and ecological factors.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Current Indicator Measurement: Unknown

Current rating comment: OSMP lacks data to provide a current rating or estimate. Since this indicator is based upon a three-year average, data from the first and second year of surveys will be used as interim measure to estimate condition and guide management.

Confidence of the current rating: Medium

Desired Rating: Good

Desired rating comment: The desired rating is based upon the objective of having a majority of prairie dog colonies support the commensal horned larks. This objective is provisional, and may be changed based upon measured values.

Conservation Target: Black-Tailed Prairie Dog and Associates

Category: Condition

Key Attribute: Animal Species Composition

Key attribute comment: This key attribute acknowledges the strong relationship between predators and an ecologically functioning prairie dog colony. Although it is unlikely that the current suite of predators will exert a limiting effect on prairie dog numbers, predators play an integral role in the functioning of a healthy prairie dog complex (Kotliar et al. 1999). The presence of predators, especially sensitive predators dependent upon prairie dogs, reflects a greater level of ecosystem integrity and complexity of a prairie dog colony when compared to colonies lacking predators (Desmond and Savidge 1996, Goodrich and Buskirk 1998, Kotliar et al. 1999).

Ecosystem integrity is often dependent on top-down regulation by predators. Top-down means that species occupying the highest trophic level (predators) exert a controlling influence on species lower down the trophic ladder (or food chain) (Terborgh et al. 1999). Ecologists studying the loss of predators have found them to be important regulators of prey species numbers (see summary in Miller et al. 2001). The elimination or reduction of predators can result in changes to plant species composition, due to relatively uncontrolled numbers of the herbivores that feed upon seeds and seedlings. The widespread prairie dog colonies in the Grassland Planning Area may be due in part to the absence of an effective predator such as the black-footed ferret.

The black-tailed prairie dog predator species identified for the Grassland Plan are:

Generalists

Bullsnake

Coyote

Fox (red or gray)

Rattlesnake

Red-tailed hawk

Sensitive

Badger

Bald eagle

Ferruginous hawk

Golden eagle

Rough-legged hawk

Northern harrier

Indicator: Predator community composition/abundance

Indicator Ratings:

Poor: No predators present

Fair: At least one generalist predator detected at 50% of colonies

Good: At least one generalist predator species detected at 50% of the colonies AND one sensitive predator species detected at 25% of colonies

Very Good: At least one generalist predator species present at 50% of colonies AND at least one sensitive predator species present on 25% of colonies AND breeding by either badger, ferruginous hawk or northern harrier on OSMP system

Indicator ratings comment: Generalist predators are ubiquitous and commonly recorded on OSMP prairie dog colonies. OSMP's conservation objective ("Very Good") requires that a portion ($\geq 25\%$) of current colonies attract a sensitive predator. This threshold (25%) was deemed appropriate given the life history of the listed sensitive species and the variation in size and landscape context of OSMP prairie dog colonies. "Very Good" meets all qualifications of "Good" and requires documentation of a breeding attempt by a sensitive predator on or near a prairie dog colony. "Very good" may be difficult to achieve due to fragmentation and disturbance of habitat. However, OSMP's objective is to manage for habitat capable of supporting breeding by

sensitive predators. The presence of adjacent large grasslands managed by other agencies may contribute to the ability of local systems to support breeding populations of these predators.

Monitoring design will consider habitat quality, colony size and surrounding land use since most predators, especially sensitive species, require larger, relatively undisturbed tracts of land for foraging/hunting. Surveying will be performed during the summer to coincide with breeding for predator species. However, some surveys might be performed later than that to assess colony use by species that usually only winter in the Boulder Valley.

Confidence of these indicator rating descriptions: Medium

Indicator Measurements:

Date: 10/15/2007

Current Rating: Fair

Current rating comment: Incidental observation data collected during 2007 prairie dog mapping; no documented nest sites in 2007.

Confidence of the current rating: Low

Desired Rating: Very Good

Desired rating comment: OSMP considers the sustainability of the predator community (including sensitive predators) to be a strong measure of conservation success.

Other comments: These indicator ratings are based on a three-year average to account for variability in prairie dog abundance due to plague events and natural life cycles, and annual variations in predator populations and ranges.

Some of these species occur semi-regularly on OSMP prairie dog colonies in winter (ferruginous hawk, northern harrier, bald eagle, rough-legged hawk) but far less often in during the breeding season. Monitoring will be designed to distinguish over-wintering from breeding individuals.

Conservation Target: Black-Tailed Prairie Dog and Associates

Category: Size

Key Attribute: Extent of Active Prairie Dog Colonies in GPA

Key attribute comment: OSMP staff identified active prairie dog colonies as a size-based attribute to track the viability of this target. The indicator for this attribute is the number of acres of active prairie dog colonies in the Grassland Planning Area. OSMP maps the extent of active colonies annually. Due to resource and time constraints, the department does not count or estimate the numbers or density of individual animals or burrows as part of the annual mapping project. OSMP has conducted mapping of active prairie dog colonies since 1996.

The extent of prairie dogs in the GPA has fluctuated due to natural population growth, relocation, predation, disease—including plague and other sources of mortality. Although the extent of active prairie dogs colonies has declined precipitously in the GPA during periodic plague outbreaks, populations have repeatedly recovered due to a small number of survivors re-establishing colonies or migration of animals from surrounding unaffected colonies. OSMP has also relocated prairie dogs from outside the GPA into areas vacated by plague.

Prairie dogs can survive in small isolated patches in the GPA. However, while these small colonies perpetuate the species, they do not represent the optimal situation for conserving associated species. Larger prairie dog colonies in the context of intact grasslands are better able to support associated species. Larger colonies are, in general, more likely to persist over time, in part, because they support more individuals. Ideally, OSMP would be able to protect a large contiguous (5,000 acre) prairie dog complex rather than many smaller areas. However a preserve system that includes many, separate colonies may reduce the likelihood of local extirpation by plague, and allows recolonization from

unaffected individuals or nearby colonies. The threat of plague aside, the landscape context resulting from urban and agricultural land uses in the Boulder Valley provides few if any opportunities for the “single large” prairie dog complex. In fact, such complexes are ecoregionally uncommon (Grunau et al. 2006).

Through an examination of habitat suitability and landscape context, OSMP identified three relatively large complexes as the best opportunities to conserve this target and a number of smaller areas to ensure the on-going existence of the target in the Boulder Valley. The large complexes (Grassland Preserves and associated Multiple Opportunity Areas) comprise approximately 8,450 acres. These areas however are sufficiently far from one another and separated by enough unsuitable habitat (urban Boulder, four lane highways, etc.) that they cannot be considered to function as one preserve. The three areas are approximately 4,000, 3,500 and 700 acres in size. In addition six smaller and isolated colonies, or Prairie Dog Conservation Areas, were identified as places where prairie dogs with or without associated species would be conserved.

Rather than manage for a specific acreage of prairie dogs based upon a population viability model, OSMP derived a range of acceptability for acreage based upon what could actually be provided on the landscape. Since the large Grassland Preserves are meant to be sustainable for long-term occupation, OSMP developed an occupancy range from 10 to 26%. Populations above 26% were considered to be too high based upon habitat availability, and the desire to have a matrix of habitats near prairie dog colonies. Populations below 10% were considered too low because there would be less habitat (disturbance, prey) for the associated species.

Data collected over the past decade suggests that prairie dog populations will be able to rebound from plague outbreaks, and that the range of acceptable variation falls well within population levels from which the local prairie dog population has recovered in the past. OSMP mapped fewer than 200 acres of active prairie dogs after a plague epizootic in the early 1990's. In 2005, there were 3,500 acres of active colonies. Some of that increase was due to new land acquisitions; however, most of it resulted from natural recolonization or human-mediated relocation. The frequency of plague infection is highly variable and unpredictable. During the inter-epizootic intervals, colonies tend to increase in extent. However, it is possible that plague epizootics will operate differently in the future or conditions affecting the availability of animals for recolonization will shift. In this situation, viability standards, and strategies for maintaining this target, will be re-examined.

Indicator: Acres of active prairie dog colonies

Indicator Ratings:

Fair: >3,137 acres or <800 acres

Good: 800-3,137 acres

Indicator ratings comment: OSMP staff has developed a land designation system for prairie dogs that places OSMP lands that had been occupied by prairie dogs at any time from 1996-2008 into one of five management classifications. The management classifications are criteria-based, so that as new areas are occupied by prairie dogs, they can be appropriately designated. The designations are Grassland Preserves, Multiple Objective Areas, Prairie Dog Conservation Areas, Transition Areas and Removal Areas. The conservation of this target is the focus in Grassland Preserves and Multiple Objective Areas. The conservation of prairie dogs, with or without associates, is the focus of the PCAs.

Full occupancy by prairie dogs in Grassland Preserves would not provide opportunities for colony expansion or vegetation recovery. In order to address concerns over the long-term sustainability of the Grassland Preserves, OSMP has established an acceptable range of variability for prairie dog occupancy from 10 to 26%.

The minimum acceptable occupancy for prairie dogs was defined as ten percent of the Grassland Preserves or 804 acres. The maximum acceptable occupancy in the planning area was defined as the sum of:

- 2,100 acres = 26% of the acreage of Grassland Preserves
- 498 acres = the acreage of Multiple Objective Areas
- 539 acres = the acreage of Prairie Dog Conservation Areas

3,137 acres

In addition to occupancy standards, OSMP followed the model of Grunau et al. (2006) to establish vegetative condition standards to characterize acceptable conditions in prairie dog colonies. Conditions within Grassland Preserves may fall below the threshold that permits relocation. In these cases, OSMP staff will need to determine if it is possible to relocate to PCAs in order to maintain this indicator within the range of acceptable variation.

Indicator Measurements:

Current Indicator Measurement: 1733

Current Rating: Good

Current rating comment: The current rating is based upon 2008 OSMP prairie dog mapping. Plague is known to be active in the GPA, and it is likely 2009 numbers will be lower.

Desired Rating: Good

Desired rating comment: See “Key attribute and indicator”, and “Indicator rating” comments above.

APPENDIX E
INDICATORS OF ECOLOGICAL CONDITIONS

TABLE E1 INDICATORS OF ECOLOGICAL CONDITION AT BOULDER RESERVOIR

PLANT COMMUNITY	VEGETATION RATINGS			
	Very Good	Good	Fair	Poor
Mixed Grass Native Prairie	<ul style="list-style-type: none"> Native grasses dominant with ≥4 indicator species such as blue grama, needle and thread, western wheatgrass, silver sage, fourwing saltbush, yucca, Junegrass, buffalograss, snakeweed, scurfpea. Nonnatives <5% cover. Not disturbed or fragmented. Connectivity of adjacent habitats allows natural ecological processes, <i>e.g.</i>, wildlife foraging, movement, and migration. No barriers, <i>e.g.</i>, roads, fences, trails. 	<ul style="list-style-type: none"> Native grasses dominant with 3 indicator species such as blue grama, needle and thread, western wheatgrass, silver sage, fourwing saltbush, yucca, Junegrass, buffalograss, snakeweedscurfpea. Nonnatives <10% cover. Disturbance is apparent but not enough to have a notable impact on species composition or soil compaction. Adjacent systems surrounding habitat retain good connectivity with few barriers. 	<ul style="list-style-type: none"> 1-2 indicator species such as blue grama, needle and thread, western wheatgrass, silver sage, fourwing saltbush, yucca, Junegrass, buffalograss, snakeweedscurfpea. Nonnatives, <i>e.g.</i>, smooth brome, bindweed, <i>cheatgrass</i>, may be >10% cover but still controllable. Disturbance is moderate. Trails and roads may have an impact on species composition and soil compaction but restoration potential is good. Adjacent systems surrounding habitat are fragmented by alteration with limited connectivity. 	<ul style="list-style-type: none"> Nonnatives dominant with little potential for control. Very low cover by indicator species such as blue grama, needle and thread, western wheatgrass, silver sage, fourwing saltbush, yucca, Junegrass, buffalograss, snakeweedscurfpea. Severe disturbance requiring extensive restoration activities. No connectivity.
Native Riparian	<ul style="list-style-type: none"> Plains cottonwood and other native woody species >75%. ≥3 indicator species including plains cottonwood, sandbar willow, peachleaf willow, box-elder, chokecherry, Woods' rose, snowberry, currant. Nonnatives negligible and, if present, have little potential for expansion. 	<ul style="list-style-type: none"> Plains cottonwood dominant. 2 indicator species include plains cottonwood, sandbar willow, peachleaf willow, box-elder, chokecherry, Woods' rose, snowberry, currant, . Low occurrence of nonnatives; potential for control or eradication is good. Streambanks may have isolated spots of slumping, 	<ul style="list-style-type: none"> 1 indicator species such as plains cottonwood, sandbar willow, peachleaf willow, box-elder, chokecherry, Woods' rose, snowberry, currant. Nonnatives may be widespread but may be contained or diminished with restoration. Streambanks show enough alteration to have affected 	<ul style="list-style-type: none"> Very low cover by indicator species. Non-natives such as Russian-olive, Siberian elm, green ash dominant with little potential for control. Shorelines are severely altered and restoration potential is low. No connectivity.

PLANT COMMUNITY	VEGETATION RATINGS			
	Very Good	Good	Fair	Poor
	<ul style="list-style-type: none"> • Streambanks are not overly steep or denuded. • Connectivity to adjacent habitats allows natural ecological processes, <i>e.g.</i>, wildlife foraging, movement, and migration. No barriers, <i>e.g.</i>, roads, fences, trails. • 	<ul style="list-style-type: none"> • erosion, or vegetation removal. • Connectivity to adjacent habitats is good with few barriers. 	<ul style="list-style-type: none"> • species composition, soil compaction, and erosion. • Limited connectivity. Some barriers and few natural ecological processes. 	
Native Herbaceous Wetland	<ul style="list-style-type: none"> • Native herbaceous vegetation dominant with ≥3 indicator species such as swamp bluegrass, sedges, milkweed, narrow-leaved cattail. • Nonnatives negligible and, if present, have little potential for expansion. No presence of species on the Boulder County Noxious Weed List. • Shorelines are not overly steep, denuded, or eroding. • Connectivity to adjacent habitats allows natural ecological processes, <i>e.g.</i>, wildlife foraging, movement, and migration. No barriers, <i>e.g.</i>, roads, fences, trails. 	<ul style="list-style-type: none"> • Native herbaceous vegetation dominant with 2 indicator species such as swamp bluegrass, redtop bentgrass, sedges, milkweed, narrow-leaved cattail. • Low occurrence of nonnatives; potential for control or eradication is good. Any species on the Boulder County Noxious Weed list may be quickly eradicated. • Shorelines may have isolated areas of slumping, sparse vegetation, and/or erosion. • Connectivity to adjacent habitats is good with few barriers. 	<ul style="list-style-type: none"> • 1 indicator species such as swamp bluegrass, redtop bentgrass, sedges, milkweed, narrow-leaved cattail. • Nonnatives may be widespread but may be contained or diminished with restoration. Any species on the Boulder County Noxious Weed list may be managed with only moderate effort. • Shorelines have many areas of slumping, sparse vegetation, and/or erosion. • Limited connectivity. Some barriers and few natural ecological processes. 	<ul style="list-style-type: none"> • Very low cover by indicator species such as swamp bluegrass, redtop bentgrass, sedges, milkweed, narrow-leaved cattail. • Nonnatives, <i>e.g.</i>, teasel, curly dock, redtop bentgrass dominant with little potential for control. Species on the Boulder County Noxious Weed List are widely present. • Shorelines are severely altered and restoration potential is low. • No connectivity.
Native Woody Wetland	<ul style="list-style-type: none"> • Native species dominant. presence of indicator species such as sandbar willow, peachleaf willow, Bebb willow, shining willow. • Nonnatives negligible and, if 	<ul style="list-style-type: none"> • Native species dominant. presence of indicator species such as sandbar willow, peachleaf willow, Bebb willow, shining willow. 	<ul style="list-style-type: none"> • 1 indicator species such as sandbar willow, peachleaf willow, Bebb willow, shining willow. • Nonnatives may be widespread 	<ul style="list-style-type: none"> • Very low cover by native woody species. • Nonnatives, <i>e.g.</i>, tamarisk, dominant with little potential for control. • Streambanks are severely altered

PLANT COMMUNITY	VEGETATION RATINGS			
	Very Good	Good	Fair	Poor
	<p>present, have little potential for expansion.</p> <ul style="list-style-type: none"> • Streambanks are not overly steep or denuded. • Connectivity to adjacent habitats allows natural ecological processes, <i>e.g.</i>, wildlife foraging, movement, and migration. No barriers, <i>e.g.</i>, roads, fences, trails. 	<ul style="list-style-type: none"> • Low occurrence of nonnatives; potential for control or eradication is good. • Streambanks may have isolated spots of slumping, erosion, or vegetation removal. • Connectivity to adjacent habitats is good with few barriers. 	<p>but may be contained or diminished with restoration.</p> <ul style="list-style-type: none"> • Streambanks show enough alteration to have affected species composition, soil compaction, and erosion. • Limited connectivity. Some barriers and few natural ecological processes. 	<p>and restoration potential is low.</p> <ul style="list-style-type: none"> • No connectivity.
Nonnative Riparian			<ul style="list-style-type: none"> • Good restoration potential. Nonnatives are dominant but native species are sub-dominant and in sufficient numbers to provide propagules following nonnative eradication and seeding of natives. • Disturbance is moderate and can be minimized with management controls, <i>e.g.</i>, fencing, signage, and education. • Streambanks/shorelines are either unaltered or can be fortified with minor planting. • There is at least some connectivity to other habitat of good or very good quality. 	<ul style="list-style-type: none"> • <10% native species cover. • Nonnatives, <i>e.g.</i>, teasel, Russian olive, reed canarygrass, smooth brome, dominant with little potential for control. • Streambanks are severely altered and restoration potential is low. • Low connectivity to other habitat in support of ecological processes.
Nonnative Upland			<ul style="list-style-type: none"> • Good restoration potential. Nonnatives are dominant but 	<ul style="list-style-type: none"> • <10% native species cover. • Nonnatives, <i>e.g.</i>, smooth brome,

PLANT COMMUNITY	VEGETATION RATINGS			
	Very Good	Good	Fair	Poor
			<p>native species are sub-dominant and in sufficient numbers to provide propagules following nonnative eradication and seeding of natives.</p> <ul style="list-style-type: none"> Disturbance is moderate and can be minimized with management controls, <i>e.g.</i>, fencing, signage, and education. Prairie dogs have the potential to exceed the carrying capacity of the site. There is at least some connectivity to other habitat of good or very good quality. 	<p>bindweed, cheatgrass, horehound dominant and with potential to alter structure and composition.</p> <ul style="list-style-type: none"> Disturbance is extensive throughout. Trails and roads significant enough to have notable impact on species composition and soil compaction, and restoration potential is low. Prairie dogs have exceeded the carrying capacity of the site. Low connectivity to other habitat in support of ecological processes.

WILDLIFE RATINGS				
INDICATORS	Very Good	Good	Fair	Poor
Birds: Grassland Nesting Species	Confirmed or Probable (M, P, T, C)* breeding of >3 indicator species -- Grasshopper Sparrow, Vesper Sparrow, Lark Sparrow, Bobolink, and Horned Lark.	Confirmed or Probable (M, P, T, C)* breeding of 2-3 indicator species -- Grasshopper Sparrow, Vesper Sparrow, Lark Sparrow, Bobolink, and Horned Lark.	Probable (M, P, T, C)* or possible breeding of one indicator species -- Grasshopper Sparrow, Vesper Sparrow, Lark Sparrow, Bobolink, and Horned Lark.	No Probable or Possible indicator species breeders surveyed.
Birds: Raptors	Confirmed or Probable (M, P, T, C)* of >3 indicator species – Northern	Confirmed or Probable (M, P, T, C)* breeding of 2-3 indicator	Probable (M, P, T, C)* or possible breeding of one	No Probable or Possible breeders of focal or common raptor species observed.

	Harrier, Bald Eagle, Swainson's Hawk, Osprey, Burrowing Owl, and Short-eared Owl.	species – Northern Harrier, Bald Eagle, Swainson's Hawk, Osprey, Burrowing Owl, and Short-eared Owl.	indicator species -- Northern Harrier, Bald Eagle, Swainson's Hawk, Osprey, Burrowing Owl, and Short-eared Owl.	
Birds: Waterfowl and Grebes	Observation of sensitive species -- Eared Grebe. Confirmed or Probable (M, P, T, C)* breeding of 3 or more indicator species e.g., Pied-billed Grebe, Cinnamon Teal, and Blue-winged Teal.	Confirmed or probable (M, P, T, C)* breeding of 1-2 indicator species, e.g., Pied-billed Grebe, Cinnamon Teal, and Blue-winged Teal.	Possible breeding of at least one indicator species e.g., Pied-billed Grebe, Cinnamon Teal, and Blue-winged Teal.	Confirmed or Probable (M, P, T, C)*breeding of common species only – Mallard, Canada Goose, and American Coot
Birds: Waders & Shorebirds	Confirmed or probable (M, P, T, C)* breeding of at least 1 sensitive species -- American Bittern, Least Bittern, White-faced Ibis, Wilson's Phalarope. Confirmed breeding of 3 or more indicator species e.g., Great Blue Heron, Black-crowned Night Heron, American Avocet, Spotted Sandpiper	Confirmed or probable (M, P, T, C)* breeding of 1-2 indicator species e.g., Great Blue Heron, Black-crowned Night Heron, American Avocet, Spotted Sandpiper	Possible breeding of 1-2 indicator species e.g., Great Blue Heron, Black-crowned Night Heron, American Avocet, Spotted Sandpiper	No probable or possible breeders of expected/common waders or shorebirds species observed.
Breeding Bird Diversity	More than 20 native breeding bird species per plot	16-20 native breeding bird species per plot	11-15 native breeding bird species per plot	10 or fewer native breeding bird species per plot
Percentage of -native species	100% of mean individuals per plot	95-99% of mean individuals per plot	90-94% of mean individuals per plot	89% or more of mean individuals per plot
Percentage of urban- adapted species	Less than 10% of mean individuals per plot	11-20% of mean individuals per plot	21-30% of mean individuals per plot	31% or more of mean individuals per plot
Amphibians	Presence of Northern Leopard Frog (S.C.). Confirmed breeding of Woodhouse Toad and Western Chorus Frog (native). Confirmation of breeding annually in locations offering suitable habitat (influenced	Confirmed occurrences and probable breeding of Woodhouse Toad and Western Chorus Frog.	Confirmed occurrences of both native and non-native (bullfrog) species.	No native frogs or toads observed or heard. Bullfrogs present.

	by water level).			
Reptiles	Confirmed presence of more than three species native to Boulder County including but not limited to the Snapping Turtle, Painted Turtle, Spiney Softshell Turtle, Racer, Western Terrestrial Garter Snake, Plains Garter Snake, and Western Rattlesnake.	At least 3 native species confirmed.	One to two native species.	Few to no occurrences of native reptile species.
Small Mammals	Confirmed presence of more than 5 native small mammal species. Monitoring of species richness and abundance (over 5 yrs). shows a stable to upward population trend	Confirmed presence and likely breeding of three to five native small mammal species. Monitoring of species richness and abundance (over 5 yrs) shows a stable to upward population trend.	Confirmed presence only one native small mammal species. Monitoring of species richness and abundance (over 5 yrs) shows a decrease in total number of native species and a decrease in population trend.	No occurrence of native small mammal species.
Carnivores	Confirmed presence of greater than three native carnivore species (e.g, Coyote, Raccoon, American Badger, striped skunk) with broad habitat requirements. For aquatic habitats the presence of Mink.	At least three native carnivore species confirmed.	One to two common native carnivore species confirmed.	Few to no occurrences of native carnivore species confirmed..
Butterflies and Skipper Habitat	Grassland composition contains abundant occurrences of little and big bluestem for larval food.	Grassland composition contains moderate occurrences (of $\geq 8\%$) little and big bluestem for larval food.	Grassland composition contains few occurrences of little and big bluestem for larval food.	Grassland composition contains no little and big bluestem for larval food.
Historical Presence/Restoration Potential	List of species that were historically present; Almost no decrease in diversity from historic; w/high potential for restoration/recovery	Minor decrease in diversity from historic; Moderation potential for recovery	Moderate decrease in diversity from historic; Limited potential for recovery	Significant decrease in diversity from historic; Recovery unlikely

*CO Breeding Bird Atlas Codes for Probable : M=mating, P=pair, T=territory, C=courtship

Notes: Could add grassland dependent butterflies and skipper observations as indicators of grassland health in future if included in monitoring plan. See pp D-6-7 of Grassland Plan for further discussion. Monitoring every 5-10 yrs with 2 consecutive years ea to assess trends.

“Viable populations of Ottoe skipper (*Hesperia ottoe*), Cross-line skipper (*Polites origenes rhena*), Arogos skipper (*Atrytone arogos iowa*), Dusted skipper (*Atrytonopsis hianna turneri*), and Regal fritillary (*Speyeria idalia*) are indicators of a healthy and functioning foothills grasslands system.”

Trends for amphibians and mammals can be added later if monitoring conducted.

Vegetation rankings are modifications of Ecological Systems Descriptions of the Colorado Natural Heritage Program (2005).

*Wildlife rankings are based on bird survey information for the reservoir, OSMP's Grassland Ecosystem Management Plan, and consultation with XYZ....?

S.C. = Colorado State Species of Concern

Ranking Table -- Numeric

Overall Condition Scores based on % of Possible for that target P=0-25% F=26-50% G=51-75% VG= 76-100%

	Condition by Management Zone								**OVERALL CONDITION	Possible based on current sitewide opportunit y	Total score	%
	Dry Creek	Coot Lake	Little Dry Creek	North Shore	North Dam	South Dam	South Shore	Western Uplands				
Native Wetland Herbaceous (WH)	3	3	2	3	3	1	1	3	G	32	19	59%
Mixed Grass Native Prairie (MGPM)	2	NA	2	2	3	1	NA	3	G	24	13	54%
Native Riparian (NR)	3	3	3	2	NA	NA	NA	NA	G	16	11	69%
Native Woody Wetland (WW)	3	3	2	3	NA	NA	NA	NA	G	16	11	69%
Birds: Grassland Nesting Species	2	2	1	1	2	2	2	NA	F	28	12	43%
Raptors	3	1	3	1	1	1	1	1	F	32	12	38%
Waterfowl and Grebes	4	3	1	1	1	1	1	1	F	32	13	41%
Birds: Waders & Shorebirds	4	4	4	2	1	1	2	1	G	32	19	59%
Percentage of native bird species	3	3	3	4	3	4	2	NA	G	32	22	69%
Amphibian s	2	2	1	1	1	1	1	1	F	32	10	31%
Reptiles	1	2	1	1	1	1	1	1	F	32	9	28%
Small Mammals	1	1	1	1	1	1	1	1	P	32	8	25%
Carnivores	2	3	2	1	1	1	1	2	F	32	13	41%
Zone Summary*	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair				
total	33	30	26	23	18	15	13	14				

Possible is
same for
all to allow
comparison
across
zones

52 48 52 52 44 44 40 36
63% 58% 50% 44% 35% 29% 25% 27%